Eliminate those annoying appliance ZAPS!

SILICON CHIP

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ALL NEW DESIGN!

mini theremin

Building our FANTASTIC new "Studio Series" preamp

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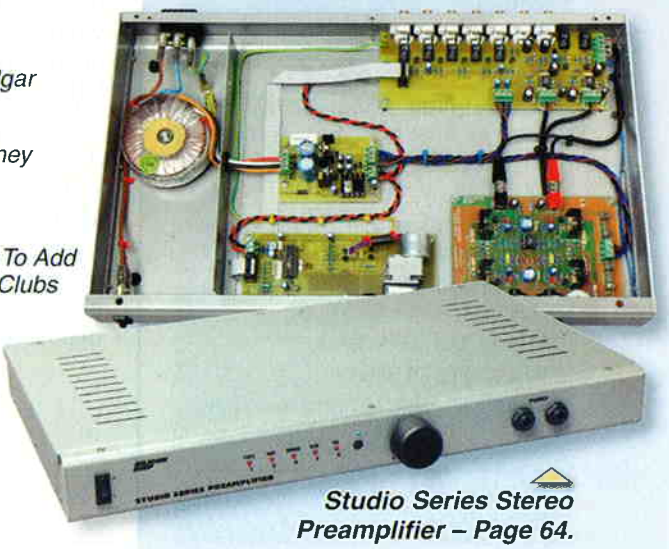

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Publisher's Letter

Nuclear power debate should look at the whole picture

Back in the January 2006 issue, we advocated that Australia should build nuclear power stations and now surprise, surprise, Prime Minister John Howard has launched a national debate on the subject. Good. But already a number of prominent people have started making hysterical statements and you wonder whether the ensuing debate is likely to be logical and carefully considered.

It is not enough to consider nuclear power in isolation. We should also be reviewing all existing methods of power generation: coal, gas-fired, bargasse, wind, hydro, solar and so on. For example, if we want more wind power, the existing base load power stations must be able to cope with the vagaries of this form of generation. In addition, coal-fired stations and carbon dioxide sequestration should be considered. The cost and complexity of this system, if it even works, must be carefully considered in making future power decisions.

As well, Australia's needs for desalination and water resources in general should also be part of the picture. Australians are woefully ignorant of how much energy is required to bring water to them and then to take it away in the form of sewage. The New South Wales government's recent decision to cancel the Kurnell desalination plant and to concentrate in future on water recycling just shows the extent of the problem; water recycling for sewage is almost as energy intensive as desalination! In fact, some years ago we editorialised that when Australians drink water, they are effectively eating coal!

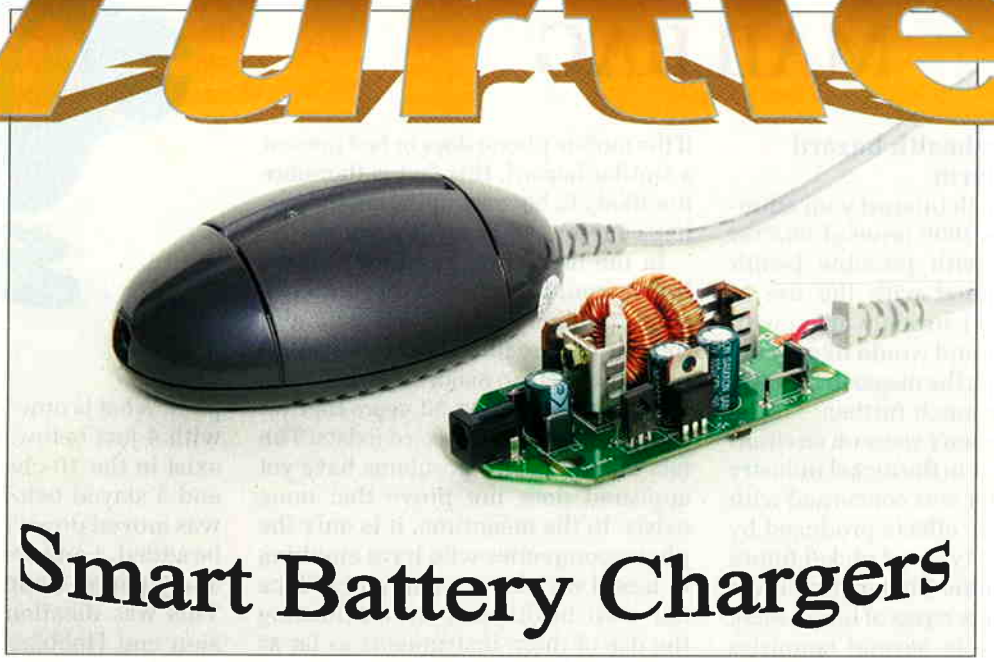
Another prime example of general ignorance about water and electricity resources was the decision by the States and Federal government to sell the Snowy Hydro scheme, now fortunately cancelled. I would not have minded so much if the Snowy had been sold, if the price had not been so incredibly cheap, compared with its cost of replacement!

We need to consider the total costs of every form of power generation, from the initial method of extraction and transport (for coal, gas, uranium or whatever), the cost of power generation itself and the eventual cost of plant decommissioning, restoration of open-cut mines, carbon trading and so on. Ultimately, the decision should come down to cold hard economics.

In the final result, I suspect that the best and cheapest course will be for Australia to use its vast natural gas resources for all future base load power stations. Gas is clean burning, does not spew radioactive particles into the atmosphere as happens with burning coal and is potentially more efficient than coal-fired stations. It also costs less to transport and there is no gaping open-cut mine to restore at the end of it all. Rather than exporting all our natural gas overseas, we should be using some of it here to meet our energy needs, for both electricity and transport.

Leo Simpson

Turtle



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MAILBAG

Mobile phone health hazard may be long-term

I have read with interest your editorial in the June 2006 issue of SILICON CHIP, dealing with possible health hazards associated with the use of mobile phones. I strongly agree with your comments and would like to suggest that perhaps the magazine should take the matter much further.

I worked for many years on environmental problems in the nickel industry and in particular was concerned with the carcinogenic effects produced by some particular types of nickel fumes in the atmosphere. This material was the cause of many cases of lung cancer in the industry in several countries around the world and the overall story was very similar to the situation with cigarette smoke and asbestos.

Radio frequency radiation has also been recognised as the possible cause of similar cancer problems, with high voltage power lines and radar transmitters being among the prime suspects. In this case, the main variables are the frequency and the intensity of the electromagnetic field. The mobile phone is, of course, only a low-powered device but the inverse-square law and the fact that the phone is usually located only a few centimetres away from the brain suggests that it may possibly pose a significant hazard.

I think that one of the most important aspects of the three separate cases mentioned above, which involved dusts, was that the health problems usually only appeared 20 to 30 years after the initial exposure to the hazard. If the mobile phone does in fact present a similar hazard, this fact is therefore not likely to become apparent for perhaps another 10 to 20 years or so.

In the meantime, it appears to me that it would be prudent to conduct a strong publicity campaign to minimise the use of these phones as far as possible. It is only if no major effect becomes apparent in the next 20 years that we can say that no real hazard exists. The fact that no health problems have yet appeared does not prove that none exists. In the meantime, it is only the phone companies who have anything to lose if we play it smart and reduce our own health risk by minimising the use of these instruments as far as is practical.

Bert Hollebon,
Cloverdale, WA.

Australian TV tests at Brisbane

I thoroughly enjoyed the article in the June 2006 issue but you didn't mention that the tests at the Old Mill in Brisbane continued up to the outbreak of WW2 when they had reached 240 lines. There was also a demonstration in a house in Brighton (Vic) in 1949, as was reported in "Radio and Hobbies" magazine. Also, when Alfred Zworykin visited Melbourne in 1951/2, he demonstrated his latest invention, the Vidicon camera.

It's also worth noting that in 1960 it was realised that some of the original 10 channels planned would not be available in time to start the country stations. This led to a new 13-channel plan. What is now 5A was originally 5, with 4 just below. Channel 0 did not exist in the 10-channel plan and 1, 2 and 3 stayed below the FM band. 10 was moved down slightly so 11 could be added. 1 and 2 moved up to allow 0 and 3 joined 4 and 5 in the FM band. This was detailed in "Radio Television and Hobbies" in 1960 (August, I think).

The FM band was occupied from 1949 to 1960 by FM tests in Brisbane, Sydney, Melbourne and Adelaide.

Wenlock Burton, VK3YWB,
Darley, Vic.

Winch controller could be simplified

The winch controller published in the January 2006 Circuit Notebook is indeed a credit worthy design but the inputs to a PICAXE chip are Schmitt triggers. Therefore all of the circuitry that de-glitches the inputs (IC2, IC3, IC5 and all associated components) is not needed. The debounce function of this extra circuitry can be done in software. Removing all these components will make the unit much cheaper and a lot smaller.

Jeff Monegal,
Via email.

Comment: you're quite correct but both design concepts (ie, the hardware and the software approach to switch debouncing) are valid. The way we see it, Circuit Notebook is not necessarily about the cheapest, simplest way to achieve a result.

June 2006 cover credits

I have just picked up the June 2006 issue from my local newsagent. As usual, it is an interesting read, particularly the history of television in Australia.

Your cover photograph shows a TV set and lounge chair which is very reminiscent of that era when TV first came into our homes. However, I thought it was customary for magazines to include a short synopsis of the front cover photograph or at least an acknowledgment or identification of any people included therein.

I cannot find any such mention in the magazine of the very beautiful lady on your June cover and I think she deserves that recognition. The photograph with the model is just so 'spot on' for authenticity so I think we readers should know who she is and somehow "Ms June" just doesn't seem fitting.

Bob Howie,
via email.

Comment: glad you liked the issue and the cover. The lady is Julie, daughter of Kevin Poulter, who wrote the TV series. Julie has a keen interest in 50s and 60s decor, fashions and memorabilia.

It occurred to us that you might want to know other details as well, since they are all authentic to the period, including the house itself. The aluminium venetian blinds were probably made by Luxaflex while the polished floor is Australian cypress pine (very popular at that time). The AWA Deep Image TV is in working condition although the Channel 9 TV pattern was dropped in electronically by Kevin Poulter (who also took the photo).

Other props include the TV chair with wool boucle cushions (probably made by Parker Furniture) and the anodised aluminium TV lamp. Julie Poulter is wearing a 1950s cotton halter dress with atomic starburst print, 1950s "Curvees" suede high heels and 1950s "Weiss" Lucite and rhinestone jewellery.

Early TV experiments in Australia

Thanks for your article on television in Australia, in the June 2006 issue but the Australian connection is much more important than you portrayed. In writing this I am working from memory so some details may be wrong but I believe it was a Mr Saunders from Ballarat who used the telegraph lines to send the signals and modulated the light of a kerosene lamp with a Kerr cell to show the 1896 or 1898 Melbourne Cup in Ballarat.

He realised that the telegraph system did not have enough bandwidth and he had no amplifiers so he stopped development. The Melbourne museum some years ago had his apparatus set up for display. Unfortunately, his work has generally been forgotten.

Rod Cripps,
Parkdale, Vic.

Fire sensor for sprinkler system

I am writing with regard to the reader's request for a fire sensor in the "Ask SILICON CHIP" pages of the May 2006 issue. Several years ago, I worked for an organisation (Cerberus) in a technical support role with respect to fire detection systems. In their range of products was a flame detector but the price today would be prohibitive for the "private" user (around $700 per unit) wanting to provide protection for an unoccupied property. As a guide, the device was capable of detecting a methyl alcohol flame (little to no visible signs) in a tea-candle container at about five metres.

The general philosophy of any fire detection system is that it only has to work long enough for the occupants to evacuate the premises and that it should be "out of sight, out of mind" until it is required. With respect to unattended systems and approaching bushfires, the smoke density (obscuration) will be likely to be at alarm levels at a significant time before the fire front arrives and temperatures will be at elevated levels because of radiant heat from the fire, making ordinary smoke type and heat type detectors ineffective. Factors such as environmental temperature, wind speed and direction, humidity, fuel load and neighbouring vegetation all affect the speed and intensity of the fire front.

Pre-wetting is a good idea in that it interrupts the fire triangle (fuel, heat and oxygen) by reducing heat through evaporation but delaying the wetting down reduces its effectiveness, and starting it too early just wastes water. If one assumes that there is a bushfire, then there are no guarantees regarding reliability of electricity supply or water supply, meaning that alternative

Acid-free resin flux paste

I saw the request for acid-free flux paste in the Ask SILICON CHIP pages of the April 2006 issue. There is a very easy way to make your own resin flux. Go to a music store and buy a block of resin (it is used on bow strings). Crush it up very finely and mix it with a small amount of methylated spirits to make a paste. Spread it on the clean copper, solder and you don't have to clean it up after.

Arthur Prince,
Via email.

Comment: thanks Arthur. That is a good way to make a mild solder flux. However, an analysis is likely to reveal that it is not completely acid free. It will have a number of organic acids related to the tree species from which it originated.

Atmel's AVR, from JED in Australia

JED has designed a range of single board computers and modules as a way of using the AVR without SMT board design

The AVR570 module (above) is a way of using an ATmega128 CPU on a user base board without having to lay out the intricate, surface-mounted surrounds of the CPU, and then having to manufacture your board on an SMT robot line. Instead you simply layout a square for four 0.1" spaced socket strips and plug in our pre-tested module. The module has the crystal, resetter, AVR-ISP programming header (and an optional JTAG ICE pad), as well as programming signal switching. For a little extra, we load a DS1305 RTC, crystal and Li battery underneath, which uses SPI and port G.

See JED's www site for a datasheet.

AVR573 Single Board Computer

This board uses the AVR570 module and adds 20 An./Dig. inputs, 12 FET outputs, LCD/Kbd, 2xRS232, 1xRS485, 1-Wire, power reg. etc. See www.jedmicro.com.au/avr.htm

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software.

Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.

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supplies (pools and tanks) must be utilised and mechanical pumps used to pressurise the spray system.

The amount of R&D that had gone into the aforementioned flame detector was significant – especially with regard to flame flicker frequencies and other flame behaviours. Without being negative, it might be a little optimistic for someone to design (and get right first time) a fire-front detector that can break out the fire pump, put the foot in the pool/tank/dam, prime the pump, divert the pre-wet system and mop up without human intervention.

All of the above points pretty pessimistically to the fact that a human must be at "ground zero" with enough intelligence to make certain decisions about the situation.

Another way to consider it might be like this: if you can't afford to lose the asset, you can't afford to be uninsured. Furthermore, if it really is valuable, why is it remote and unattended?

Mike Frede,
Albury, NSW.

Nuclear fusion will be worth the wait

As you probably know, the world's first nuclear fusion plant is to be built at Cadarache in Southern France at a cost of 10 billion euros. It has been estimated that if this process can be successfully harnessed, then there is enough fuel available to supply the planet's energy needs for at least 1000 years. It would also go a long way toward solving the effects of global warming created by the continued burning of fossil fuels.

In a news item in the May issue of IET there is a report of a study into safety with respect to these new generation nuclear power plants and the authors have concluded that a severe environmental impact would be "impossible" and that even the "most severe" accident would not require public evacuation.

Because of the technical difficulties that still have yet to be resolved, this plant is not expected to be commissioned before 2045-50. My hope is that we will see a result well before this. Countries such as New Zealand and Australia should have a watching brief on these developments rather than moving into generating plants using nuclear fission.

John Rogers,
via email.

Comment: there is no certainty that nuclear fusion will ever be safely harnessed for power generation. If it is successful, the world will never have an energy shortage. However, Australia cannot afford to wait for 30 years or more for the possible outcome of nuclear fusion research. It is highly likely that we will have many nuclear fission power plants by that time. **SC**

$10000 PRIZE POOL!

2006 SILICON CHIP
Excellence in Education Technology Awards
NOW OPEN

SILICON CHIP magazine aims to promote the education, development and application of electronic technology in all fields throughout Australia. As part of that aim, we are announcing the SILICON CHIP Excellence in Education Technology awards, with a prize pool of $10,000. Separate awards will be made to students of secondary schools throughout Australia and to students of universities and TAFE colleges throughout Australia.

The secondary school awards will have three categories:

(a) Best final year assignment of an individual student involving electronics technology
(b) An award to the school sponsoring the winning individual student
(c) Best school project involving electronics technology

The university and TAFE college awards will have three categories:

(a) Best project from a student as part completion of a degree, diploma or certificate in electronics or a related field (ie, mechatronics)
(b) Best research project from a post-graduate student working in an area of applied electronics
(c) An award to the university faculty or school sponsoring the best research project.

Entries and judging

The awards will be judged by the editorial staff of SILICON CHIP, convened as a judges panel. The decisions of the judges will be final.

Entries for the 2006 awards are now open, with final submissions to be made by September 30th, 2006. All submissions will be confidential, until the winners are announced, in the December 2006 issue of SILICON CHIP.

Each award will take the form of a cash prize and a commemorative plaque. All enquiries about these awards should be directed to the editor via email to: awards@siliconchip.com.au

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Add two serial ports to your notebook.
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What's New?

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Cat 18211-7 Reader + Software $175
Cat 18210-7 Tags $69

RAID Server

Great for servers this RAID device takes two IDE drives and mirrors them. If one drive fails it will work from the other until the faulty one is replaced and then rebuild "on the fly" to minimize downtime.
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This unit allows the user to remotely control 7 Digital I/O ports and 1 RS232/422/485 port over LAN or WAN.
Cat 15157-7 $329

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Take your 3G wireless internet access anywhere! These USB adapters allow the use of a wide number of high speed datacards via a USB port. This enables these PC cards to be used with a desktop or laptop without a CardBus slot.
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ExpressCard is the new standard in notebook addon card replacing the older PC Card (PCMCIA) standard. Our current range of ExpressCards include USB 2.0, SATA II, Gigabit, Firewire 800, Serial & Parallel.
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Stores up to 1000 barcodes

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Allows two workstations to operate the one PC. Supports PS/2 keyboard and mouse with VGA monitor.
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Silent Barcode Scanner

With it's vibration alert this new silent scanner is perfect for use in loud environments (eg warehouses), quiet environments (eg libraries) or for people with disabilities. Normally after a "good-read" a barcode scanner will beep, this unit vibrates instead.
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PCI to PCMCIA Adapter

This PCI card allows the use of PCMCIA and PC Card devices designed for notebooks in a standard desktop PC.
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USB to IDE Cable with Power

Connect any IDE drives to your PC using a high-speed USB 2.0 port. An external power adapter for drives is included.
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EPROM Programmer

This programmer connects to the LPT port and has a 32 pin ZIF socket. It will program from 16k to 8M.
Cat 3159-7 $479

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Switch any electrical device on or off using SMS from any mobile phone.
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7

MoTeC

Part 1:
by Julian Edgar

Race Car Data Logging

More information than you'd believe!

Optimising the engine and suspension of racing cars has always been a technologically intensive pursuit but the ability to log and then later analyse data has taken the sport to a new level.

Australian motorsport specialist MoTeC is at the forefront of racing car electronics, producing digital dashboards, engine management systems and data analysis software.

This month we'll look at how racing car data is collected and then next month, examine MoTeC's i2 data analysis software.

So what sort of data is collected from a racing car?

Engine

Collecting data on the engine status is made simpler because the engine management system's Electronic Control Unit (ECU) already uses many sensors.

The outputs of these sensors can be used not only by the engine management system but also logged and then expressed in engineering units.

In addition, the ECU has available internally calculated data, such as injector duty cycle.

- **Engine Load**

On naturally-aspirated race cars, load is normally calculated by the engine management ECU looking at engine speed and throttle position. (This is in contrast to road cars that most often use an airflow meter to directly measure the mass of ingested air.)

Forced aspirated racing cars (that is, those with turbo or supercharged

Fully configurable digital electronic dashboards are used to display sensed data and log it for later analysis. In addition, output alarms can be set when certain combinations of parameters are met. Data can also be scrolled through by the driver pushing a button.

engines) use a Manifold Absolute Pressure (MAP) sensor that measures manifold pressure. When this is combined with measurement of engine speed, the ECU can again work out load. So when engine load is logged, the data is in the form of either throttle position and engine speed, or manifold pressure and engine speed.

While it might first appear that this is a complex way of logging engine load, in fact in racing car applications it is advantageous.

This is the case because engine load is most often used in conjunction with the logged air/fuel ratio to work out where in the load range the engine is running richer or leaner than desired.

Since the fuel injector outputs are determined from an ECU map of throttle angle (or MAP) versus engine speed, having available throttle position and rpm (or MAP and rpm) allows the engineer to quickly find the load site at which the problem is and then make the appropriate tuning change.

MAP sensors are calibrated in absolute pressure and are most commonly available in 1 Bar (suitable for naturally aspirated engines), 2 Bar (ie suitable for 1 Bar of boost) and 3 Bar (suitable for 2 Bar of boost) versions.

Interestingly enough, there is also available a 1.05 Bar version which takes into account the aerodynamic air pressure build-up possible in the airbox of a fast-moving car.

Most often used are Delco MAP sensors which start at $80. These conditioned sensors have a nominal 0-5V output and are widely used in production cars.

• Coolant , Oil and Intake Air Temperature

Coolant and oil temperatures are measured by NTC thermistors. The Bosch 023 and 026 sensors are commonly used – at $17 they are cheap, use a near universal 12 x 1.5mm thread and are 2-wire designs (ie, no chassis ground return) that use a standard fuel injector plug.

Intake air temperature sensors comprise a similar design but with the thermistor exposed to the passing airflow.

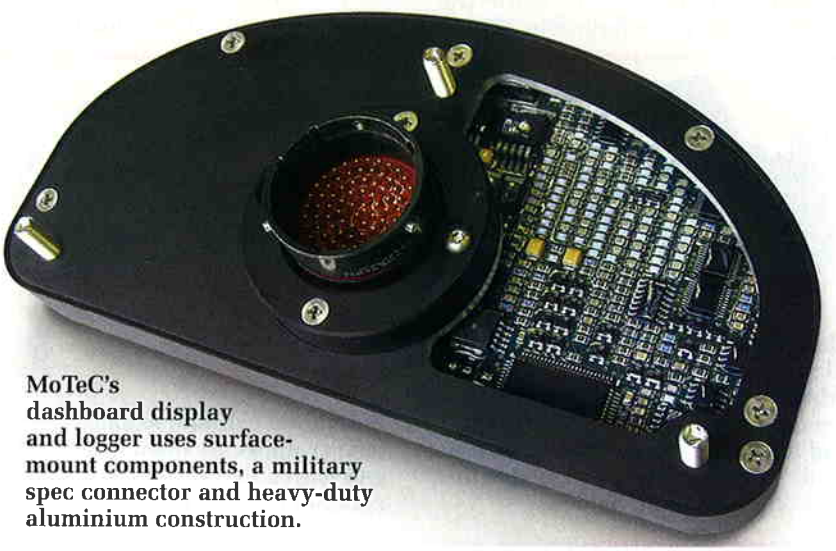
Intake air sensors can be used to sense air temperature in an intake runner just prior to entry into the engine (so measuring the temperature rise caused by the air compression of a supercharger or turbo, and intake manifold heat soak) or at the airfilter.

• Air/fuel ratio

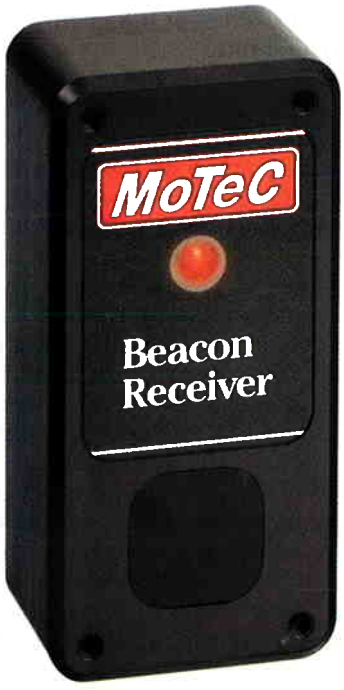
Previously, the air/fuel ratio was measured by a zirconia oxygen sensor such as the Bosch "four wire" design. Based very much on the technology of the oxygen sensors used in normal passenger cars, this device outputs a voltage of 0-1V, depending on mixture strength. However, the voltage is non-linear with respect to air/fuel ratio, with a sudden change in output around 450 – 550mV (corresponding to the air/fuel ratio passing through stoichiometric) and also varies with temperature. The Bosch unit has a slightly flatter response than garden variety oxygen sensors but still has severe limitations in accuracy, especially at the rich end of the automotive scale. Linearising it requires accurate temperature and voltage compensation.

Replacing the Bosch "four wire" unit is the Bosch LSU probe. This probe works on a completely different principle and requires its own control circuit. In short, a zirconium-dioxide/ceramic measuring cell is used comprising a Nernst concentration cell and an oxygen pump cell, with a small diffusion gap positioned between them. Two porous platinum electrodes are placed within this gap – a Nernst measuring electrode and an oxygen pump electrode. The gap is connected to the exhaust gas via a small passage.

On the other side, the Nernst cell is connected to the atmosphere by a reference air passage. By applying a pump voltage across the electrodes, oxygen is pumped from the exhaust gas into or out of the diffusion gap.



MoTeC's dashboard display and logger uses surface-mount components, a military spec connector and heavy-duty aluminium construction.



(Left): an infrared receiver placed in the car watches for the output of a suitably coded trackside infrared transmitter. In this way, accurate lap times can be logged and also displayed on the in-car digital dash.

(Right): these expansion units allow a greater number of inputs to be logged by the digital dash or the engine management ECU. The E816 has an additional 18 analog voltage inputs and eight PWM outputs, while the E888 has eight analog voltage inputs, eight K-type compensated thermocouple inputs, four digital inputs and eight PWM outputs.

The sensor controller varies this voltage so that the composition of the gas in the diffusion gap remains at stoichiometric.

If the exhaust gas is lean, the pump cell pumps the oxygen to the outside (positive pump current). If the exhaust gas is rich, the oxygen is pumped from the exhaust gas into the diffusion gap (negative pump current). The pump current therefore reflects the actual air/fuel ratio. Again, linearising is required.

Other than the most recent M400/600/800 series MoTeC engine management systems and the PLM air/fuel ratio meter, no MoTeC logging device can accept a signal directly from the LSU sensor. Instead they read the data from the ECU or PLM via a CAN bus communication, while the PLM also has a configurable analog output voltage that can be read by the data logger.

• Exhaust Gas Temperature

Exhaust gas temperature is measured with K-type thermocouples. Again, an interface device is needed, this time to amplify and cold junction compensate the signal.

One example of such an interface is the $1045 MoTeC E888 input/output expander. Amongst other inputs and outputs, this unit can accept eight K-type thermocouple inputs and then communicate this data to the engine management ECU or digital dash logger by means of a CAN bus connection.

Exhaust gas temperature is most often measured at individual exhaust outlets near the engine, so explaining the requirement for eight probes in many race car applications. These give a guide to cylinder-to-cylinder mixture consistency and are most commonly used in drag racing.

• Oil, Brake and Fuel Pressures

Two types of sensor are used in these applications. The first is the traditional Bourdon tube based potentiometer, as exemplified by the large canister VDO units used as oil gauge pressure sensors on countless road cars.

However, the accuracy of these sensors in race car applications is suspect: when tested on the bench, a light finger tap can sometimes change the measured output by 5 psi!

Replacing these are Texas Instruments sensors that use a load cell backed by a diaphragm. Available up to 2000 psi maximum pressures, these sensors have a conditioned 0-5V output and are available in gauge and

Manifold Absolute Pressure (MAP) sensors made by Delco are used in conjunction with RPM and intake air temperature to measure load. These sensors are available in 1, 1.05, 2, 3 and 4 Bar versions.

Individual cylinder exhaust gas temperatures are often measured and logged to indicate cylinder-to-cylinder mixture consistency.

Bosch LSU sensors are used to sense the oxygen concentration of the exhaust gas and from this, work out the actual air/fuel ratio. These new sensors replace the older zirconia design and are faster and have higher accuracy over a wider measuring range.

absolute pressure configurations.

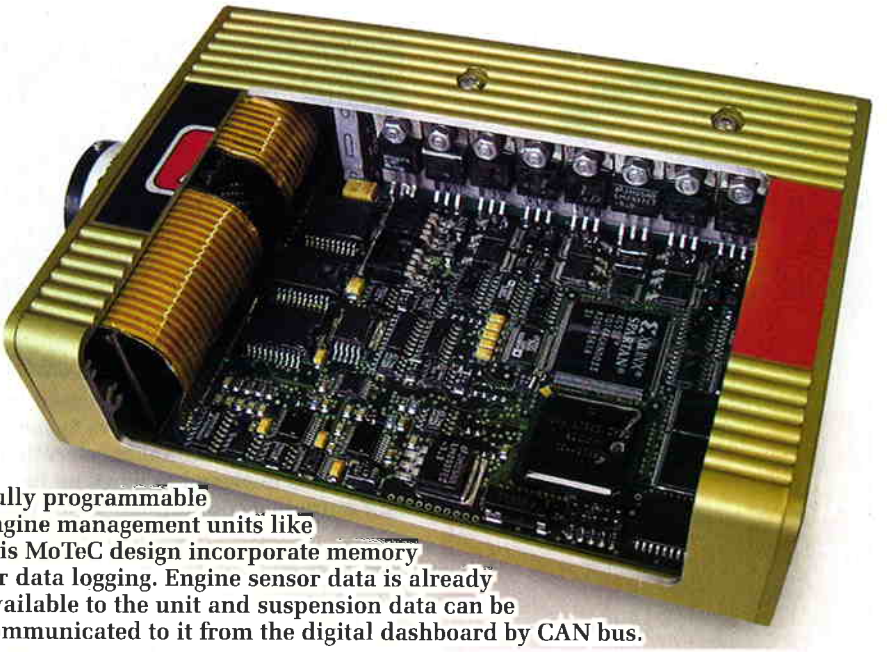
- **Throttle Position**

Throttle position sensors comprise rotary potentiometers mounted on the throttle shaft. They are available in a wide range of physical designs to match various shafts but a common one accepts a D-shaped shaft. As we will see next month, knowing what the driver is doing with the throttle is a vital component in race car data analysis.

- **Engine Speed**

Engine speed is sensed from the crankshaft position sensor. This normally comprises an inductive sensor mounted on flywheel, although in engines not specifically built for racing but instead adapted from road cars, the sensor can alternatively be optical or use a Hall Effect device.

Other sensors that are sometimes uses on the engine include infra-red thermometers measuring block temperature and pressure sensors in the coolant system, the latter used primarily to sense a catastrophic loss of coolant.



Fully programmable engine management units like this MoTeC design incorporate memory for data logging. Engine sensor data is already available to the unit and suspension data can be communicated to it from the digital dashboard by CAN bus.

Chassis and Suspension

Suspension data requires the installation of specific sensors. Where the behaviour of individual wheels needs to be monitored, this involves four sets of sensors.

- **Damper Movement**

Damper movement is sensed by linear potentiometers. These are available with different stroke lengths (for example: 75, 100, 125, 150 and 200mm) and are mounted such that they move over as much of their range as possible as the suspension moves from full bump to full droop.

These sensors cost about $400 each but they are fully rebuildable, something often required as their vulnerable positioning results in frequent damage in racing incidents. Finding space for the sensors and mounting them so that no bending loads are placed on them can be difficult; however, the logging software can be easily configured to show actual suspension deflection even when the sensor is angled from the vertical or is subjected to a non-linear motion ratio.

- **Damper Temperature**

The temperature of the oil within the dampers is sensed indirectly, either by the use of stick-on thermocouples or, less commonly, by infra-red temperature sensors.

- **Lateral , Longitudinal and Vertical Acceleration**

One, two and three axis accelerometers are used to sense accelerations. These sensors are conditioned with a 0-5V linear output and can be specified to have maximum acceleration of 10g. (In Top Fuel drag cars the previous 4g maxima were being exceeded in longitudinal acceleration!) However, in circuit racing cars, two-axis accelerometers with a maximum acceleration of 4g are more normally used.

Cost varies from $360 for a single axis 4g accelerometer to $688 for a 3-axis 4g sensor.

As we will cover next month, the outputs of this sensor can be used by the data analysis software to automatically construct a track map.

The accelerometer is normally mounted at the roll and pitch centre of the car. However, two accelerometers can be individually mounted on the front and rear axle lines and when their outputs are compared to steering angle, be used to assess the magnitude of oversteer and understeer.

- **Yaw**

Yaw is sensed by a Bosch yaw sensor, as normally fitted to the Subaru STi model WRX that uses an active

Linear potentiometers are used to sense damper movement. Data interpretation software allows damper speeds to be calculated from this displacement data, allowing optimal bump and rebound settings of the dampers to be set.

Hall Effect sensors are used to sense engine speed, a parameter used by the engine management ECU and also logged for later analysis.

Load-cell-based pressure sensors are used to measure oil, brake and fuel pressures. In some cars, even the coolant pressure is measured!

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A dual axis accelerometer is used in most data-logged racing cars to sense lateral and longitudinal acceleration. The unit is designed to work up to 4g and outputs a conditioned 0-5V signal.

centre differential as part of its four wheel drive system. In addition to a yaw rate signal output, this sensor also contains a lateral accelerometer. Cost is $1014.

- **Tyre and Brake Temperatures**

Tyre and brake temperatures are monitored by infrared thermometers aimed appropriately. In the case of Le Mans racing cars, no less than three infrared sensors are used per tyre – quite a cost at $480 each sensor! Tyre temperatures are amongst the most useful of data in setting-up a car for optimal lap times as the temperature distribution shows how hard each tyre – and each part of the tyre – is working. The infrared thermometers have a conditioned 0-5V output and are available in 100°, 200° and 1000° Celsius ranges – the latter being used to measure brake temps.

- **Steering Angle**

Steering angle is normally sensed by a multi-turn rotary potentiometer driven by a toothed rubber belt from a pulley mounted on the steering shaft.

- **Road Speed**

In road cars adapted for racing, the ABS system is usually disconnected. In these cases, one of the inductive wheel speed sensors can then be used for measuring road speed. The logging software is configured for the AC voltage levels of the sensor and the frequency/speed relationship. In purpose-built race cars, a new inductive sensor is fitted behind a wheel.

Lap Time

Car racing is about going faster than anyone else and so lap speed is a critically important parameter.

MoTeC use a trackside mounted infrared transmitting beacon and a car mounted receiver. A configurable frequency signal is emitted by the beacon and the car's system is programmed to respond to only this signal.

Lap times are logged and also displayed to the driver in terms of laps to go or lap number. In addition, split times can be gained by the use of extra trackside beacons programmed appropriately.

Logging and Displaying the Data

Given the number of channels and the frequency at which many are collected, most teams choose to use in-car logging rather than real time telemetry. (Telemetry is still used but for slow-changing factors like fuel levels and monitoring engine health.)

It is useful if the device that stores the data can also display some of it for the driver and so a common approach is to use a customisable digital dashboard that can perform both functions. MoTeC's Advanced Data Logger (ADL2) is such a unit.

The ADL2 can read 28 analog voltage inputs, 12 digital inputs and two Bosch 'four wire' air/fuel ratio sensor inputs.

And if even more logging capability is required, another 22 inputs can be added by means of an expansion unit! The unit will also accept data communicated to it in RS232 (eg, from a GPS unit) and CAN formats. A 16Mb internal memory is incorporated and the microprocessor is 32-bit. The fully configurable backlit LCD can display any of these inputs, shown in user-selectable engineering units.

Conclusion

As we've seen, literally anything that can be sensed on a race car is capable of being logged. However, all the information in the world is of little use if no sense can be made of it.

Next month, we'll take a look at the MoTeC i2 data analysis software which has mind-boggling capabilities – not only can it display the data in many different forms but it can also make mathematical calculations based on that data and then display those calculations in relation to the collected data! **SC**

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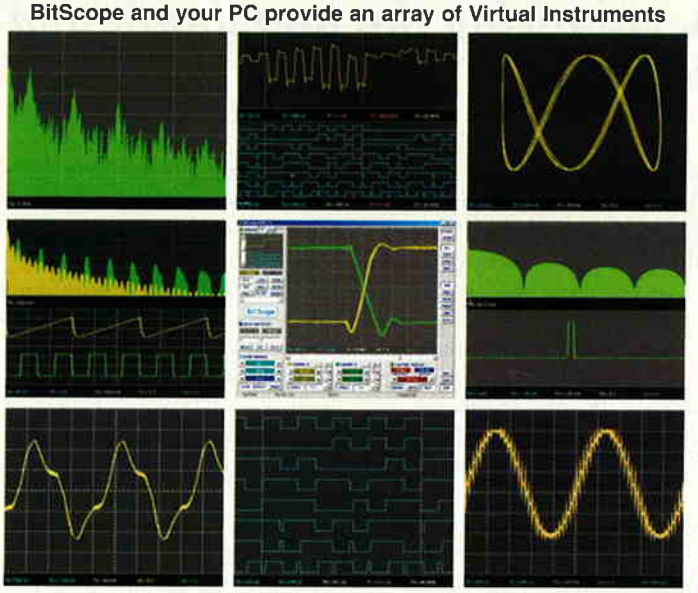

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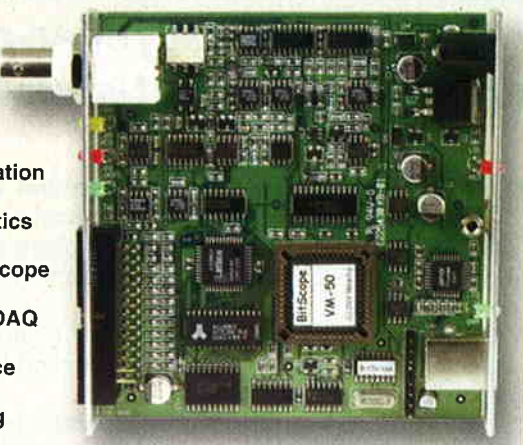

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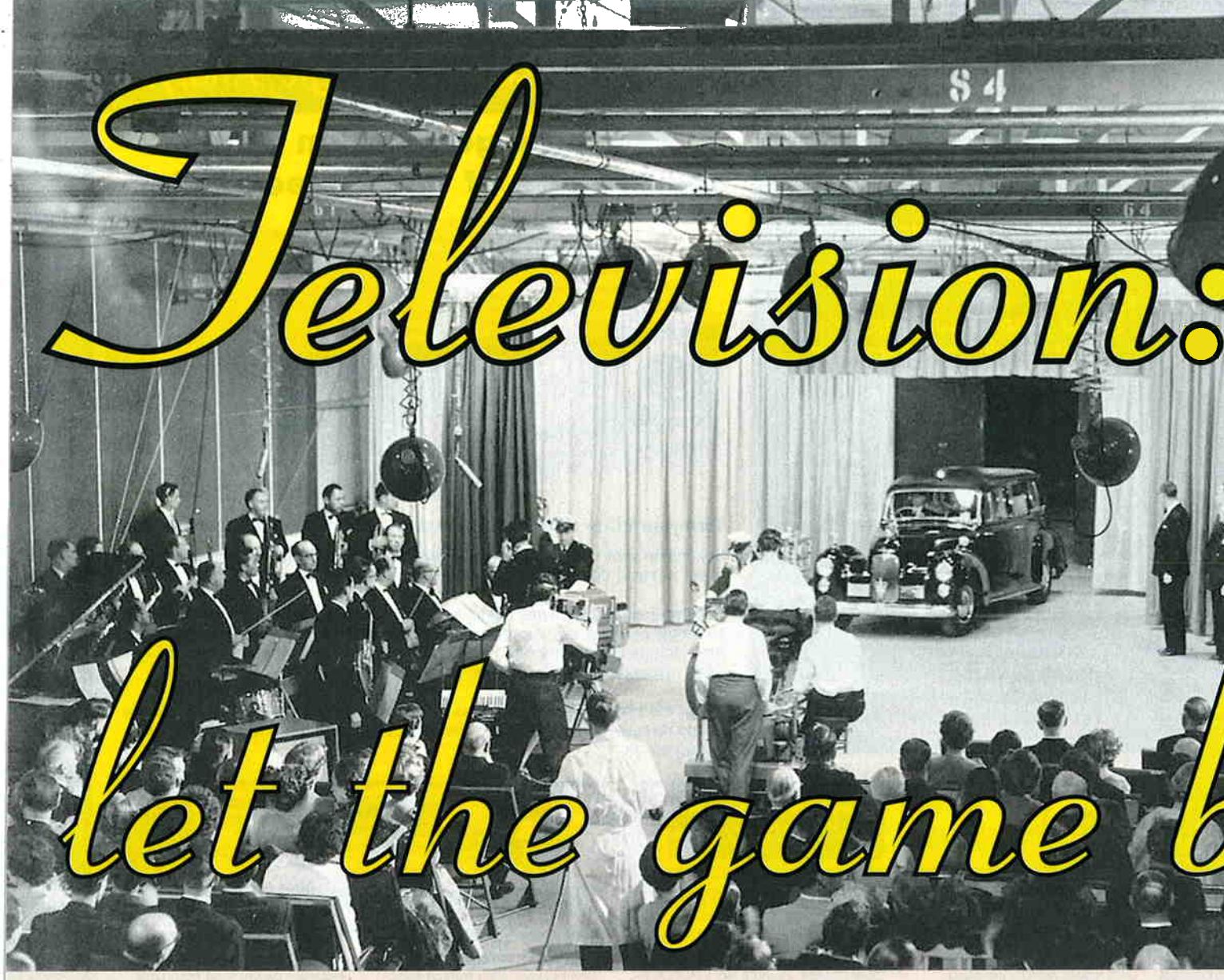

Television: let the game b

New and exciting, television was here – with euphoria reaching almost fever-pitch, capturing the imagination of an entertainment-starved nation.

This amazing new electronic medium – television – made an immense impact on society in the late fifties. Today, with dozens of TV channels, it's hard to imagine the incredible anticipation and excitement of television at the time.

TV performers became huge stars and technicians were respected as the people householders could rely on, to keep every home 'on air'.

After WW2 Astor, like AWA, sent technicians overseas, visiting top manufacturers to absorb their knowledge and experience, then commenced building experimental receivers. During 1949, Astor sent their televisions to be paraded in halls in capital cities and main provincial towns around Australia.

Before TV started, Ron Blaskett, a ventriloquist with his wooden doll Gerry Gee, was asked to perform in Channel 9 closed circuit demonstrations at Melbourne's Royal Agricultural Shows. Similar demonstrations were made at the Sydney show.

As 1956 progressed, anticipation was so frenetic, people were purchasing Astor receivers as early as June 1956, to watch test broadcasts and the test pattern.

The price of a good console was about the same as a second-hand car.

An Astor, for example, was 250 pounds (with the 1956 average annual wage about £1100) plus 25 pounds for 'installation' and another 25 pounds for the antenna to be fixed on the roof.

Many consumers believed the controls were for technicians only, so they endured a poor picture until help arrived.

At left: the Govenor of Victoria, Sir Dallas Brooks, makes the grand entrance to the GTV9 Studio, Melbourne, to officially open the four-month-old station on January 19, 1957.

Below: Astor's 1956 television range. Manufacturers (wrongly) believed that the 17-inch models would be the most popular but as it turned out, Australian TV viewers wanted bigger!

Part 2 – By Kevin Poulter

GTV9 used ventriloquist Ron Blaskett and his sidekick Gerry Gee to introduce consumers to television.

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ASTOR 21″ Consolette
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Superb console cabinet by Gainsborough shows the ideally-sized screen for the average home.

ASTOR Special 17″
An outstanding 23 valve, all-channel receiver in artistic contemporary cabinet.

Just as much items of furniture as TV sets, these three Astor sets from the late 1950s show the style of the day. They called the larger cabinet-style sets either "consoles" or "consolettes" – the one on the left was merely described as "special".

Friends you didn't know you had . . .

Any household that purchased a TV suddenly became popular with long-lost friends and neighbours.

Television antennas were installed on the chimney or inside the roof, often according to whether the owner wanted neighbours to know a TV was installed or not. Some householders installed an outside TV antenna only, just to 'keep up with the Joneses'.

Others installed the antenna inside the roof to keep the house-proud mother happy or even to avoid paying the government radio and TV licence fee.

The dreaded "RI's", or Radio Inspectors could legally enter homes but to people who could barely afford the set, the risk was relatively low.

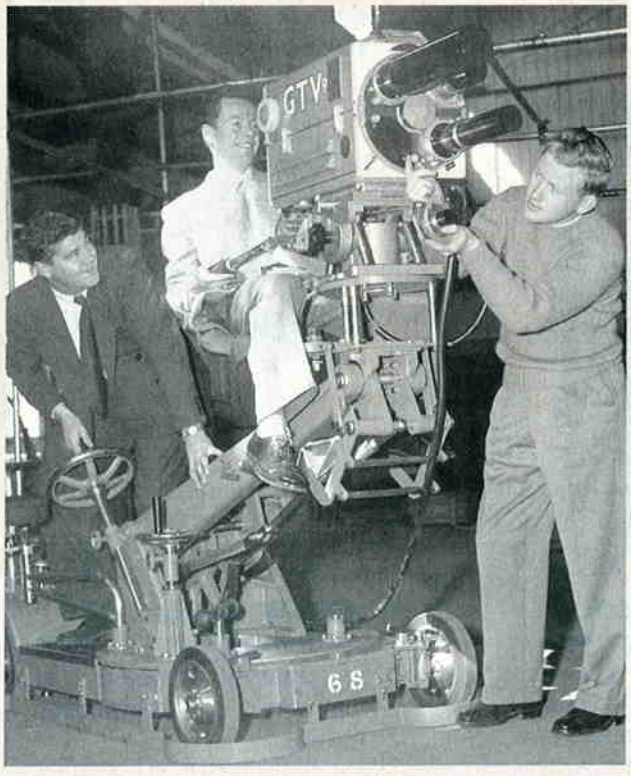
Stories circulated of owners being 'nicked' after detection by special vans that could locate noise from oscillators in the TV. It was a long time before this universally-disliked tax system (ostensibly to pay for the government-owned ABC) was abolished.

Melbourne embraced television more than any other state, probably due to the climate, interest in theatre and lack of club activity. Certainly contributing factors were that no theatres or shops were allowed to open on Sundays and hotels had to close at 6pm. TV ownership at the time as a percentage of population was Sydney 1% and Melbourne 5%.

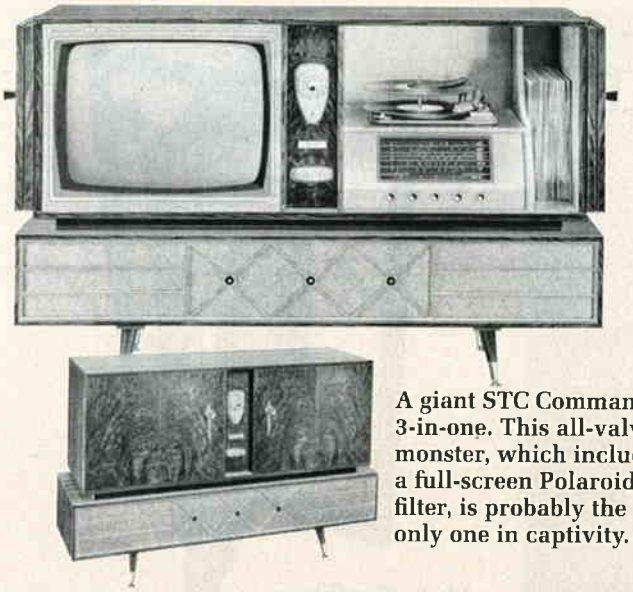
TCN9 Sydney, though, transmitted the Pelaco Golf Tournament – the first live telecast of a sporting event and the Victorian Cricket Association sold the rights to televise the cricket to the ABC – for 25 pounds!

Big investments

The electronic manufacturers were certain of the future of television and invested heavily.



More shots from the opening night at GTV Channel 9, Melbourne. At left is the camera boom with seated cameraman, made especially for high shots. Note the dress of the cameraman and grip: suits and ties, what! The team is Geoff Hiscock, Ron Davis on camera and Tom O'Donohue.
Above right is the then Governor of Victoria, Sir Dallas Brooks, taking a peek through camera 1, with cameraman Ernie Carroll driving!



A giant STC Commander 3-in-one. This all-valve monster, which includes a full-screen Polaroid filter, is probably the only one in captivity.

Inspired by the scale of US manufacturers, Astor's parent company, Electronic Industries, purchased 25 acres of land in Clayton (Vic) to build an electronics city, at a cost of 4.5 million pounds.

Electronic Industries' CEO Sir Arthur Warner's grand vision was a massive cluster of suppliers and research facilities close by, like modern car manufacturers.

His assemblage of Astor/Electronic Industries factories grew huge, with internal roads and communications networks. Soon they were joined by Gainsborough furniture (makers of fine home furniture, radiogram and TV cabinets) and PYE Telecommunications, relegated to the distant south-eastern corner of the electronics city.

However, no other related brands or suppliers ever came to fill the remaining farm countryside.

AWA erected a new 92,000 square-foot factory at Rydalmere, near Parramatta in Sydney's west and the first production was 17-inch picture tubes. At the same time, AWA's Radiola No 1 factory at the inner-western Sydney suburb of Ashfield (where the famous Radiola and Radiolettes were made from 1931) was quickly transformed into an automated carousel moving-conveyor production-line facility. The factory handled the large, heavy "Deep Image" television chassis, which were all hand-wired at that time.

Chassis, tuners speakers and cabinets came together assembled and tested with AWA's own purpose-built on-site transmitter and rolled along the conveyors to the warehouse.

Brands like Astor, Admiral, Healing and others were also highly in motion. Astor's cathode ray tubes were manufactured in 1956 by Anodeon, in nearby Huntingdale (Victoria).

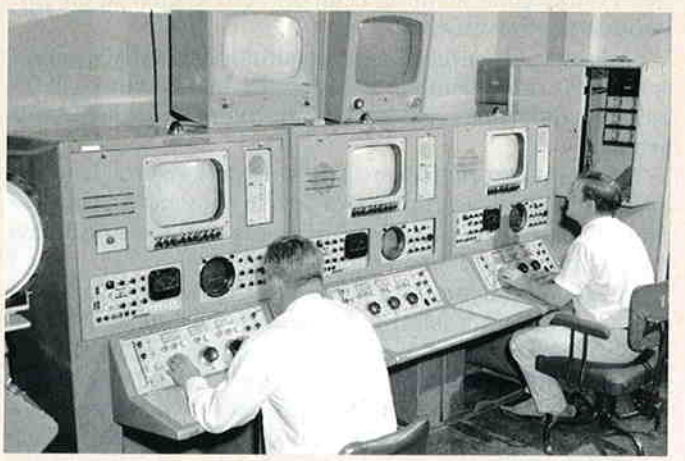
Built to last

Early TVs were well-built (like a tank), as manufacturers hadn't devised cost-cutting cheaper production techniques like printed circuit boards. The most common wiring was across tag-strips. Superb cabinets were made by furniture companies, with beautiful quality, gloss wood finishes to match furniture in even the finest homes.

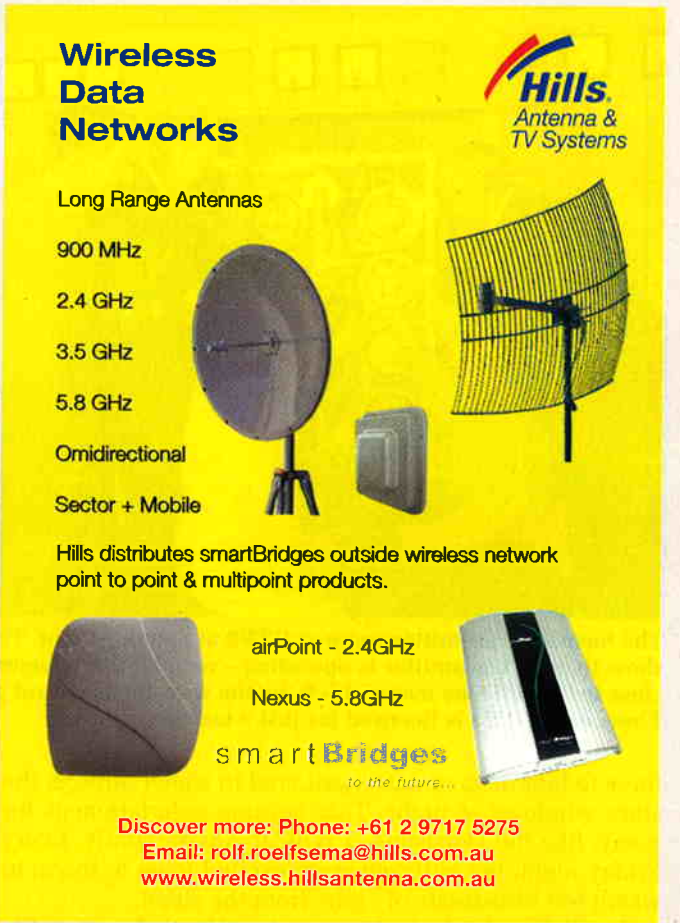
A single chassis would be the basis of a large range of sets – on legs, upright consoles with a large speaker below, or with side-mount speakers, speakers in front on one side, or both sides of the tube and many quality furniture variations. Economy televisions were tabletop models with cabinets not much larger than the picture tube, with or without long legs.

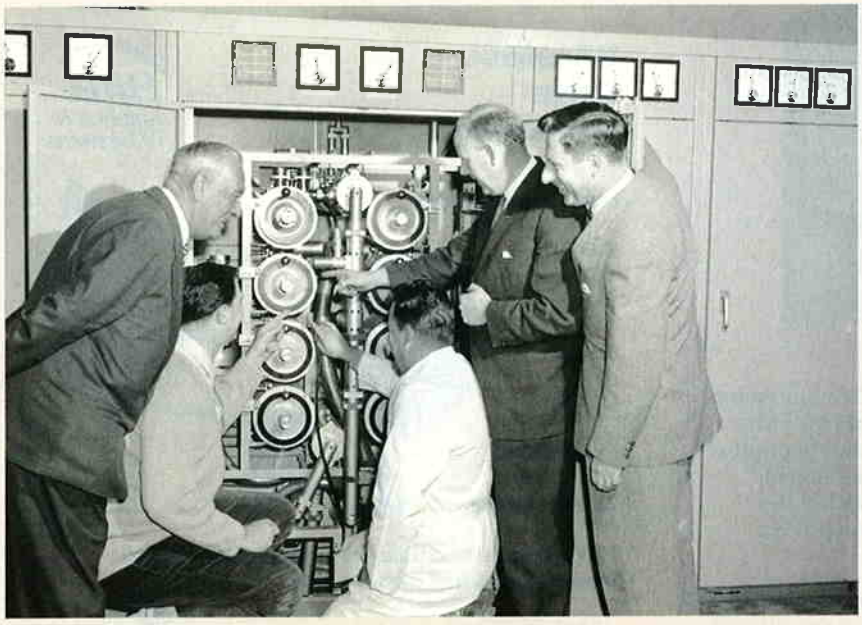
The first AWA television receivers were the 200 series, commencing with model 201T. 'T' denoted a 17-inch 70° picture tube table model, with a 23-valve deluxe chassis. These sets rolled off the production line pre-broadcasting, in July 1956, at a retail price of 209 guineas. Shortly after, the model 202c console version was produced, priced at 229 guineas.

As televisions first appeared in stores, large crowds, often



Telecine technicians controlling the quality of film converted to video.





The Siemens transmitter room at GTV9 at opening night. The meters at top show that the transmitter is operating – with all those fingers perilously close to the HT! The meter at left, by the way, reads output power as 10kW. These days GTV9 is licensed for just a tad more power!

Marconi orthicon camera tube. A sensor (top right) enclosed a tiny ball, which fell into a one-way tube if inverted in transit. This resulted in a return to the factory, as dust would show in the image.

three to four deep or more, gathered to watch through the store windows at night. This became entertainment for many, like the Harrisons, a typical Aussie family. Every Friday night, the children were excited to go to town, to watch test broadcasts of 'tele' from the street.

People bought deck-chairs and applauded – even the commercials. Some stores installed speakers under their veranda, so the crowd could hear the television too.

Stores went the extra mile, with free in-home demonstrations, even loaning a television set or two for weeks, while the householder decided.

In 1956, the Harrison family purchased a Ferris TV, a budget model with a compact metal case finished in iridescent blue, just the size of the screen. Rabbit-ears on top gave excellent metro reception. They weren't the only ears – Mickey Mouse ears were worn by thousands of excited children during the Mickey Mouse Club.

Just 11 days after TCN9 Sydney, GTV9 made Melbourne's first live transmission on September 27, 1956, hosted by Geoff Corke and broadcast from the staff kitchen at the Mt. Dandenong transmitter.

Prolonged Olympic Games negotiations finally reached agreement in November 1956, at the last minute. Channels 2, 7 and 9 televised the Olympics but only at sold-out events.

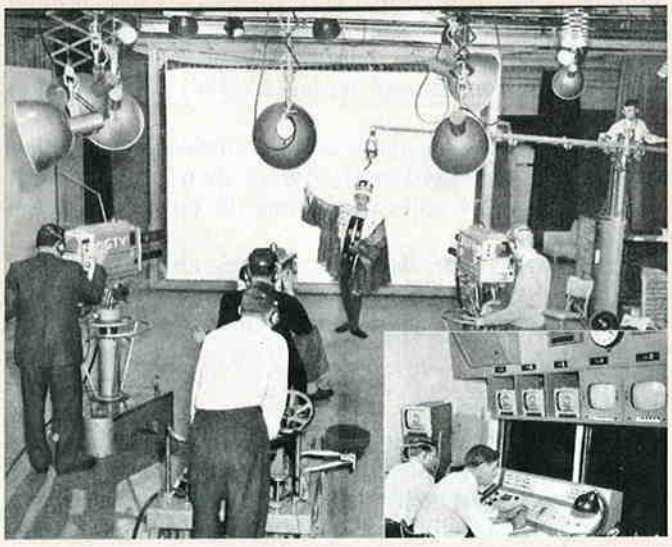
Videotape recorders were a long way off, so broadcasting was live, plus a vast number of 16mm cameras filming, for replay later. Sydneysiders and overseas audiences only saw delayed footage, from 16mm film.

Television transmitters for Melbourne were installed in a group on Mt. Dandenong, 35km from the city, with GTV9 employing a Siemens transmitter and PYE cameras. ATN Sydney built a 500-foot mast at Gore Hill. Their 72-foot aerial array and most studio equipment was Marconi of UK, supplied by AWA. Two 3-inch copper lines fed the two halves of the antenna, under a few pounds of pressure, to keep out moisture.

Over the years before official broadcasts, various Governments had pushed their ideology, from Labor decreeing television was to be all government-owned, to the Liberals reversing that to allow commercial television as well. By transmission time, the government was still fully in charge of all transmitters, through the "PMG" (Post Master General's Department).

This meant commercial TV stations mixed and converged their studio's output into a large cable – the final feed leaving the station. From this point on, the PMG had absolute control, including getting the signal to the transmitters and towers.

In the event of signal loss or quality problems after this exit point, the station engineer would telephone the PMG



It all looks rather primitive by today's standards . . . but at the time it was state-of-the-art! Do you recognise a rather young "King" of Television? Graham Kennedy was later to become one of the best-known faces on Australian TV.

siliconchip.com.au

engineer to report "all was well their end and could they please get back on air soon".

Australian TV stations lacked production experience, so they copied overseas ideas, telecasting live shows identical to stage presentations, or broadcasting overseas programs. TCN-9 transmitted just three hours each night in 1956, trying entertainment like Frank Ifield yodelling and other stage-style presentations. Their three 15-minute music shows could not compete with American drama and ceased within three months.

"We may not be the first, but we are the best"

TV stations who revelled in the one-upmanship of being first to start regular transmissions were soon torpedoed when Channel Nine Melbourne officially started in January 1957. GTV9 was immediately the envy of other networks with an enormous one million pounds worth of facilities, unofficially titled 'Studio City'.

As well as being the high-profile leader of Electronic Industries, Sir Arthur Warner was chairman of GTV9. He explained his decision to delay until they were the best. 'It would be crazy and the stupidest thing to put on low grade programs in the early stages. This is a new adventure for the Australian public, and it wouldn't be good to open with a colossal number of hours.' The strategy paid off, as soon GTV9 was filming ratings-leading productions.

Channel GTV9 Melbourne commenced official programs on January 19, 1957. Terry Dear was the presenter, with the Governor, Sir Dallas Brooks, making a grand entrance into the massive studio in his black limousine, led by motorcycle police. In front of an audience of 400 people, he declared the station open.

Viewers far and wide reported excellent picture definition and sound from the channel 9 opening broadcast, including Bairnsdale, 280 kilometres from Melbourne and other distant locations, like Ararat, Mansfield, Yea, Bendigo, Traralgon and Ballarat.

Channel Nine had an imposing camera boom, for rising above scenes, shooting with the cameraman seated – just like in the movies. Not to be left out, Seven went to great lengths to produce a devious but similar effect in a live-show. Their stills photographer photographed a singer during rehearsals with arms outstretched, from a high angle. In the live performance, as the performer opened arms, a second camera faded to the photo enlargement of an overhead view!

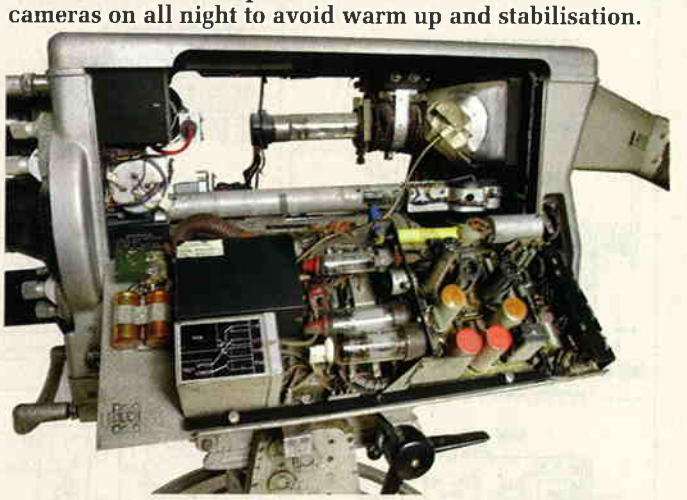
ATN-7 built their television complex at Epping in Sydney, with a main studio soon proclaimed as the biggest in the country. "In Sydney Tonight" started in the first week of transmission, with ex-radio host, Keith Walshe. Keith's quick wit and the polished production soon made the show a ratings leader.

On May 6, 1957, Norm Spencer launched "In Melbourne Tonight", hosted by a young Graham Kennedy. Graham had a 'naughty boy' reputation on radio and attracted the housewife set.

Overwhelming demand results in rationing.

After the launch of television transmissions, the industry had difficulty in meeting consumer demand. Dealers were obliged to start an allocation system, which led to an influx of imported receivers but many imports ceased after local production began to cope with supply.

Marconi MkIV camera, used from the late 60s to 70s. This one still works – after an hour or so to warm up. Stations were known to leave cameras on all night to avoid warm up and stabilisation.



Television was an expensive item, yet John Williamson, a television serviceman at the time, remembers clusters of television antennas were initially more prevalent in low-income worker's areas. Families, who were already paying off many items, added new television sets to their hire-purchase.

Government legislation required households to have a licence for their television, so the PMG figures give a reasonable indicator of sets sold. In the first month of regular broadcasting, 10,000 sets were licensed.

By February 1957, Victoria had 8,000 licences and NSW 4,000. This initial boom in Victoria was attributed to interest in the Olympic Games but as 1957 progressed, Melbourne

A Camera Control unit for the Marconi on previous page.

continued to lead television receiver sales.

Bob Dyer's quiz show "Pick a Box" started on ATN-7 and was simulcast on radio. A big "Pick a Box" winner was Barry Jones, who later became a federal member of parliament and Labor Science Minister. Barry Jones not only answered questions in considerable extra detail, he argued with some of the show's answers – and usually won.

During 1957, GTV-9 connected Melbourne with Sydney for the first time, via five mountain-top microwave links in an exercise called 'Operation Kangaroo'.

The top show for adults was 'I Love Lucy' and for children, 'The Mickey Mouse Club'.

Along with their own brand, AWA produced Westinghouse badged receivers in their factory. Re-badging was common in television, like electronics manufacturers today. Large stores including Maples and Myers also sold house re-badged brands, like the 'Maple Leaf', manufactured by Astor.

The power of advertising.

Australian content included 'The Happy Show' with Happy Hammond, broadcast from the Myer store window, though an OB van in the basement.

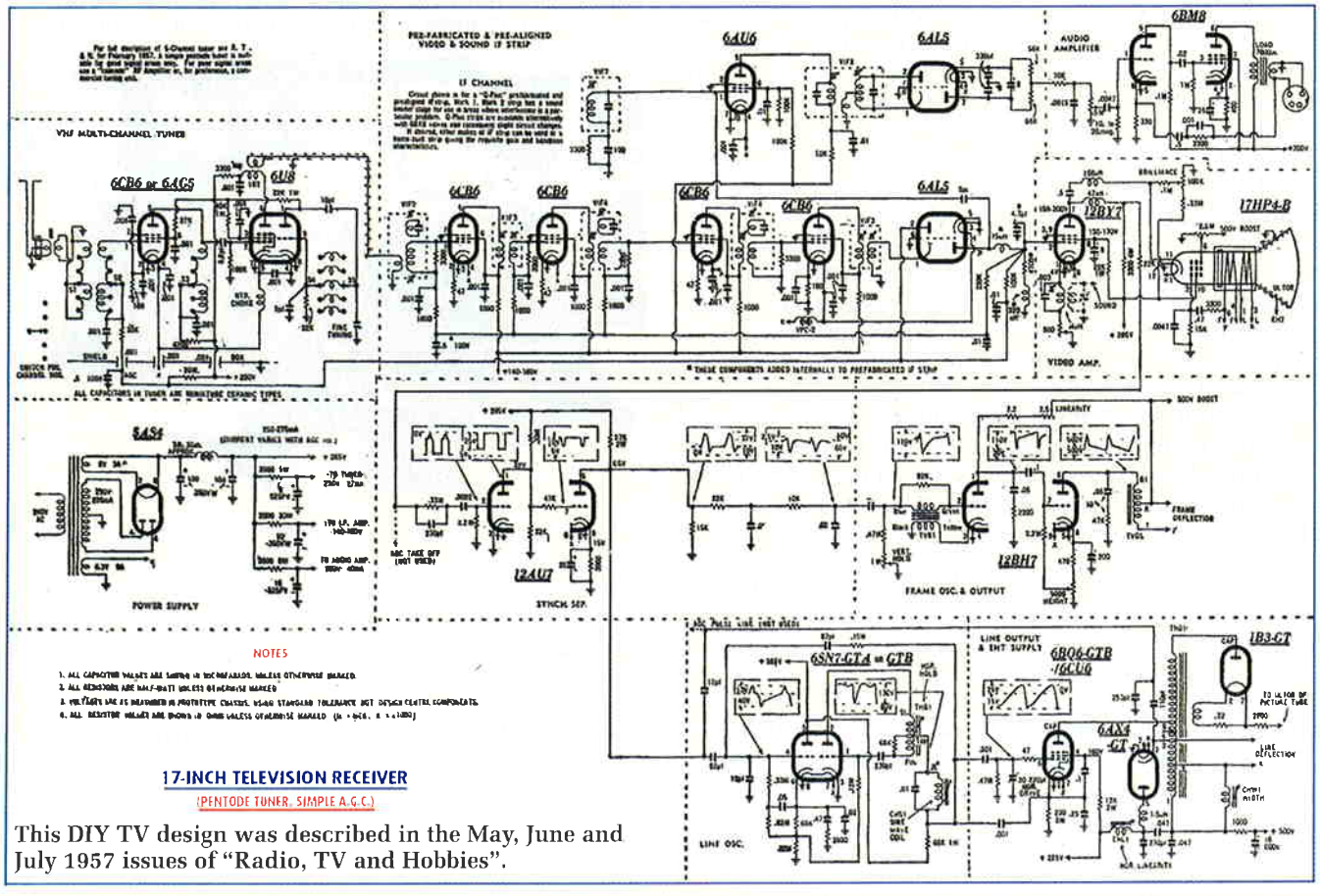
Five hundred people watched the first show from the street. Then every evening at 5.30, crowds gathered for the show, made under the brilliant illumination of three banks of arc-lighting.

Strong lighting was needed to compensate for the relatively low sensitivity of television cameras and white shirts were avoided, due to the image blooming and smearing of the camera tubes. Titles and drawings were filmed from flip-cards. Cameramen were dressed in suits or dust-coats and communicated to the director through throat microphones, headphones and hand signals.

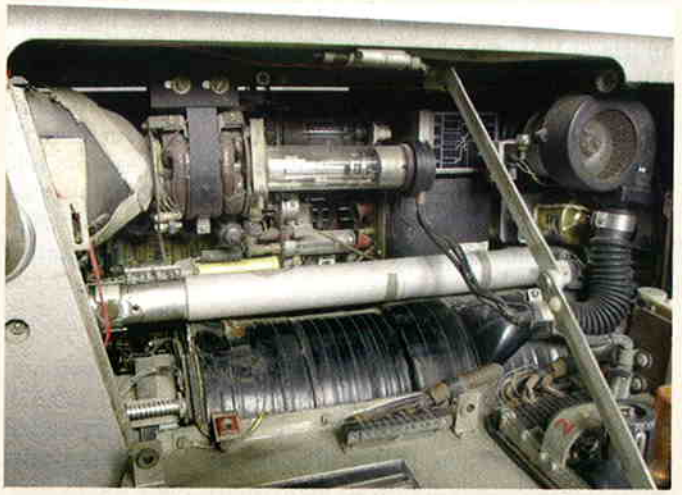
In April 1957, the Tarax Drinks Managing Director wrote to channel 9 to advise their sponsorship of the Tarax Happy Show had been so successful, they were continuing their sponsorship at a higher level and immediately allocating one hundred thousand pounds for plant and equipment to cope with increased sales.

AWA models included the 17-inch 203T and the first

CIRCUIT DIAGRAM OF 17-INCH TV RECEIVER WITH ALL IMPORTANT VOLTAGES, VALUES & WAVEFORMS



This DIY TV design was described in the May, June and July 1957 issues of "Radio, TV and Hobbies".



Inside a Marconi MkIV camera. Note the large blower and cathode ray tube for the camerman's viewfinder.

21-inch 90° tube models, the 204T table, 205C console lowboy and 206C console with doors. These also featured the deluxe chassis, but with 24 valves. Additional 5AS4 rectifiers (two in parallel) handled the extra load.

Later, in November 1957, AWA's standard 17-valve chassis was introduced, the 209C 17-inch followed by the 21-inch 212C in December.

The television industry originally predicted 17-inch receivers would dominate demand – the best compromise between screen size, clarity and cost. In fact, 21-inch models quickly became top sellers, as the 625-line transmission system gave excellent picture definition, without obtrusive raster lines being evident. Soon giant 23-inch sets were also available.

Department stores established in-store radio and TV service departments. In addition to offering best service to customers, people with sets needing repair would pass the furniture and store's products on display, potentially attracting more sales.

Two things concerned the public about television ownership – the high purchase price and fears the expensive picture tube would fail. This was not helped by early guesstimates that picture tubes only lasted about three years. Invariably, as servicemen arrived at a home for a TV repair, they were met by a worried owner, sure the problem was the tube.

This was capitalised on, with companies offering service contracts or insurance. Unfortunately, the need for TV service also attracted 'cowboys' and unscrupulous operators.

Of course, tube life was far better than this, including cases of sets still performing well beyond 15 years. Thomas Tubes' Melbourne manager said the emission life was largely determined by the number of sweeps of the cathodes by the spray gun operator. RCA Raytheon and Sylvania seemed to be particularly generous.

Large service companies began, with 'radio controlled' service. Separate sections handled antennas, workshop pick-up and delivery plus spare parts feeder vans. Technicians started from home and averaged eight calls per eight hour day (more with overtime), finishing at home around 5-10pm. Once a week the technicians would visit their base for restock and technical updates.

In the early years when a TV receiver breakdown was a 'matter of life and death' to the consumer, servicemen could work 15 hours, 7 days!

They butcher on Sunday, we fix properly on Monday

Generally extreme hours were only offered by the crooks in the trade, like the one listed in the yellow pages under every alphabetical letter. Their itemised accounts for a workshop repair were deceptive, like 'adjustment of horizontal drive', a five second job – for fifteen pounds!

The crook was featured prominently in the 'reveal all' Truth newspaper, lived in Melbourne's most expensive suburb, Toorak, sent his kids to the best schools and ran his own debt collection agency. He even had the front to appear on an ABV2 interview and wondered what all the fuss was about.

An employee said he was a capable technician but he would assign an apprentice or slower person work on the repair for a long time. When it was evident they would not get anywhere, he would take over and find the fault quite quickly – but the customer would be billed for the total time.

He had the greatest assemblage of test equipment ever seen in one place. It completely covered one wall from bench height to the ceiling. This myriad of red indicators and blinking numbers could be seen by customers through the shop front window. Very impressive – but not used, especially when no staff were there late at night.

Independent radio repairmen in 1956 without retailer connections were at a disadvantage by not having many television sets, installations and faults to learn on. War-

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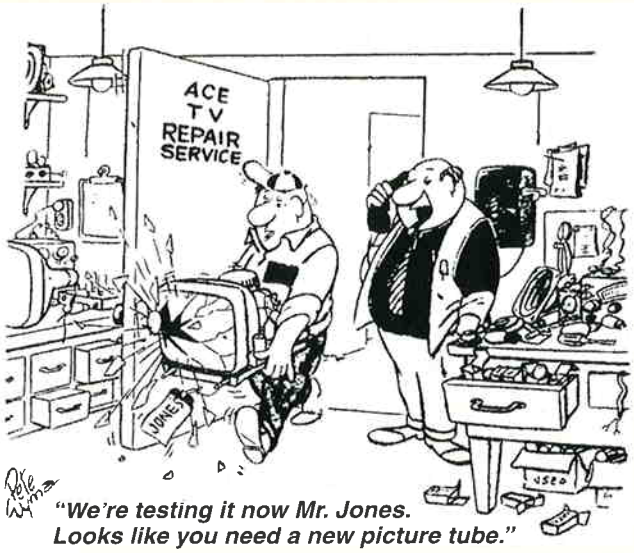

"We're testing it now Mr. Jones. Looks like you need a new picture tube."

A topical cartoon from the August 1959 issue of Radio, TV and Hobbies – itself from an earlier edition of "Radio Electronics." Unfortunately this was often too close to the truth . . .

ranties and insurance policies meant that any service was closely tied to the retailer for quite a while.

Occasionally there were disputes between a TV technician and the antenna installer/repairer, whether a snowy picture was due to an antenna fault or the receiver (two-storey building and no portable on hand). This was a good reason for always using folded dipoles, rather than the open ended fan type, so a feeder continuity reading was possible.

Service technician John Williamson recalls receiving a service call to a rural area with no house numbers. Armed with a description of the house, he travelled the dirt road until he saw a farmhouse. Nobody was home, but the door was unlocked – not unusual in those days — so he soon found the TV. Sure enough, it had faults, which John fixed and then proceeded down the road.

To his consternation, a little further down there was a house that better fitted the description. He had repaired the wrong TV! There was no option but to repair the right one and wonder what the lucky neighbour thought of the set mysteriously fixing itself.

Video tape recording

Ampex USA was the leading force in VTRs and in 1955 began to see usable images on recorders. The challenge was to fit massively greater information on tape than sound. On November 30th 1956, Ampex made the first American video recorder, an impressive recorder with four (quad) spinning heads, rotating at 14,400 rpm. Thirty-two passes of the heads composed one picture frame.

Still, Australian television was not to have access to video recorders until 1959, so our only recording option was 'telerecording', using a kinescope. This involved simply pointing a 16mm film camera at a monitor – which explains why some historical footage is low quality. 16mm film was the only alternative. This was expensive and delayed the broadcast but was top quality.

With news and overseas programming only on 16mm film, TV stations had state-of-the-art 16mm projection telecines, 16mm cameras (field and studio) and even in-house movie film processing labs.

For programming with tight deadlines, like news and sports, it was not uncommon for 16mm film to be sent to telecine still damp from processing!

Given no inexpensive recording options, most entertainment was broadcast live, 'warts and all', with memorable moments, due to no editing possibilities. These include Rover the dog starring on In Melbourne Tonight, doing what a dog needs to do – a puddle on the floor – plus performers occasionally exclaiming adjectives not in more genteel vocabularies.

1959 was a big year

New South Wales began to lead in TV ownership, overtaking Victoria's early 2 to 1 lead. Now NSW boasted 350,536 licences, compared to Victoria's 301,138. Tasmania trailed with just 87 licences. QTQ9 Brisbane began test transmissions but Darwin had to wait many more years for TV.

ATN-7 was the first Australian station with a videotape recorder. The Ampex recorder was a huge quadruplex reel-to-reel unit with massive 2-inch tapes – so bulky, each tape case included a carry handle! Due to their expense, tapes were wiped and re-used, until too many drop-outs appeared, so many classic TV moments were lost.

Other stations purchased recorders soon after, at a jaw-dropping thirty thousand pounds each! The quality was very good at the time, so the quad format was in use until the late 70's.

As labour-saving appliances flooded the market, industry grew, and cars had little ignition suppression, television reception suffered. Government technical investigations suggested the common herringbone pattern on Ch 2 was attributed to 'a transmission frequency variance from the 36 meg frequency used in Australian sets'. The Control Board also recommended a new set of intermediate frequencies.

Since television began, Australians have wanted a higher local content. 1959 was no exception, with one writer lamenting stations were following the easy advertising dollar 'by using packaged-shows of second-rate American films, instead of the hard-won Australian variety show.'

Game shows like the BP Show were huge. Often based on American concepts, viewers were dismayed to hear in 1959 that the American Senate Committee found 'fixers seduced and coached innocent quiz contestants'.

Australia held its head high, with top quality productions like Shell Presents, broadcasting new live plays every week. GTV9 continued to lead with the most popular live shows.

Generally the only programs still surviving since 1956 were comedy dramas, with Maverick the most popular western by far. In 1959, drama peaked at 49.5% of viewing time, with variety and talent just 9.3% and children's also a low 11.2%.

Any popularity list should include Father Knows Best, I Love Lucy, Beaver, Bilco (all American) and Graham Kennedy's In Melbourne Tonight. Teens were excited by the Johnny O'Keefe-produced Six O'clock Rock.

1960 – still do-it-yourself

In the 20s to the 40s, people were encouraged to make and repair radio receivers. Despite the infinitely greater complexity and high-voltage dangers of television, books like 'Australian Television Yearbook' showed how anyone could fix faults. There wasn't a circuit in sight but state-

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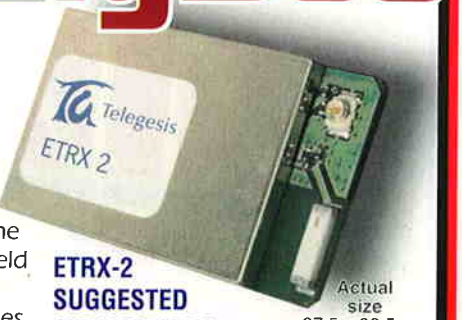

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ments like '90 percent of faults are the valve', encouraged the amateur sleuth. High-voltage warnings were included, easily overlooked by an enthusiastic amateur.

You want fries with that?

In 1957, mains voltages in some suburbs and rural areas fluctuated between a low 160 to 200 volts at night, particularly in winter, reaching highs of 255-260 volts. This was due to fewer electricity supply transformers, switching stations and regulators.

Excessive voltage caused faults like EHT arc-over, EHT socket and valve breakdown, oversized pictures and numerous component failures. Under-voltage opened up a can of worms. Customers would call with faults like a small picture.

Often this was too-easily solved by changing the mains tap on the set to a lower one, not advisable, as it fried the set when the mains supply later rose and/or missed the true problem. In fact, the fault may have been just the vertical oscillator plate resistor going high after the set had been on a while – especially if the TV remained on from children's viewing time.

Changing the transformer tap resulted in up to 100 volts more B+ HT, plus nearly 8 volts on filaments and higher EHT voltages. This preceded an estimated 60 percent decrease in component life, with capacitors and valves greatly exceeding their limits.

One owner changed his TV to the 200 volt tap, then was notified by supply authorities his mains supply was upgraded to 240 volts. On returning the tap to 240 volts, the receiver lost horizontal hold, so he reverted to 200 volts. Within two weeks, the picture tube had given up – expensive, the right voltage only needed a simple adjustment of the horizontal hold.

Servicemen were faced with the dilemma of solving voltage problems outside the design criteria of equipment. Even a VTVM powered by the mains would introduce its own error, showing approximately double the actual voltage drop.

John Williamson again: "I was called to look at a set which had five valves replaced in four weeks under a service contract, now expired. After changing the mains tap from the (incorrect) 210 volt setting, the true faults like a shorted capacitor across the stabiliser coil and other troubles were fixed and the TV gave reliable viewing."

Valves mainly suffered after a time on a low mains tap setting. When reset correctly, faults appeared in most areas of the set. However in the interests of longevity and fewer service-calls, the correct move was to the right mains tap.

Problems may not exhibit fully (or at all) when the serviceman arrived, so John Williamson called his Variac (variable mains unit with output meter) the technician's best friend.

Television was becoming a must-have and technology was adding more features each year. **SC**

NEXT MONTH:

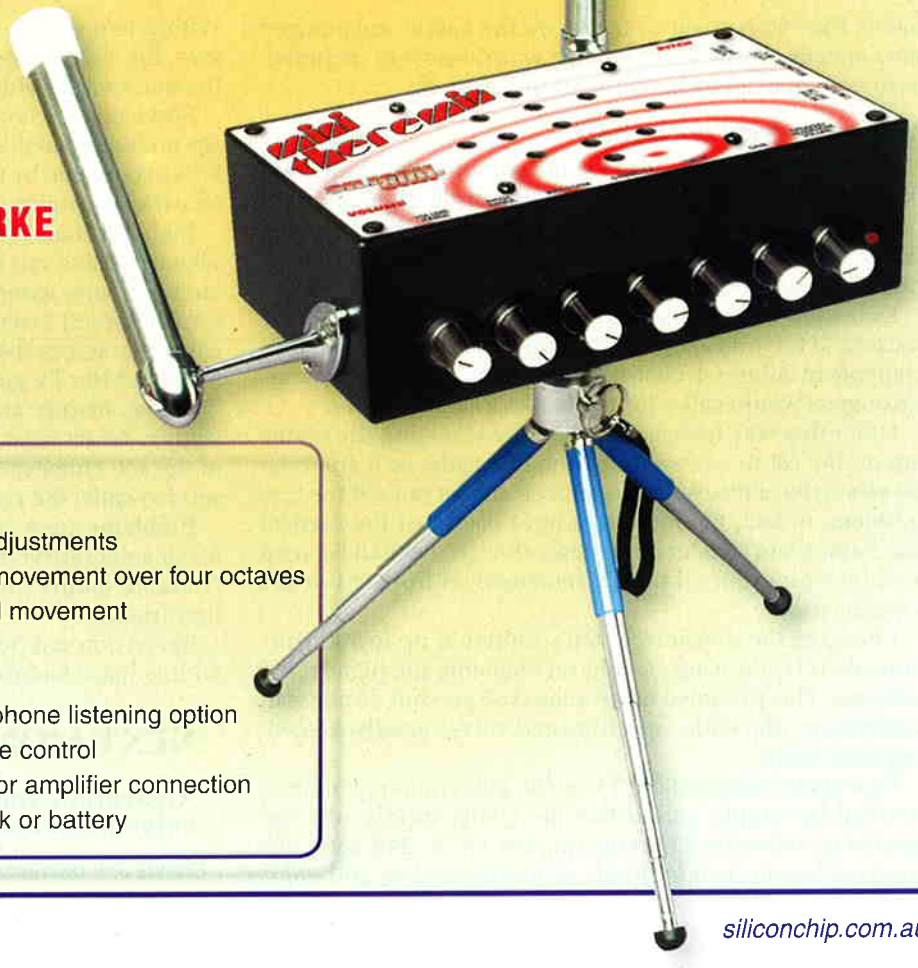
Australian Television comes of age and valve technology reaches its peak.

Credits and references are shown at: www.aaa1.biz/sc.html

mini theremin mk.2

JUST MOVE YOUR FINGERS NEAR THE ANTENNAS OF THIS THEREMIN TO CREATE YOUR OWN ELECTRONIC MUSIC OR EERIE SCIENCE FICTION SOUNDS. IT'S EASY TO BUILD, EASY TO SET UP AND EASY TO PLAY.

PART 1: By JOHN CLARKE



Main Features

- External pitch & volume span adjustments
- Linear pitch change with hand movement over four octaves
- Linear volume control with hand movement
- Three sound variation controls
- Signal level adjustment
- Internal loudspeaker with headphone listening option
- Loudspeaker/headphone volume control
- Line output with muting switch for amplifier connection
- 12V DC operation from plugpack or battery

OUR ORIGINAL MK.1 THEREMIN was described in the August 2000 issue and has proved very popular. This new Mk.2 version features a better waveform, has more controls for adjusting the tonal quality and is easier to play, with more progressive hand control.

So why are Theremins so popular. The answer is because of their extreme versatility and the uniqueness of the sound they produce, compared to conventional instruments. Even relatively simple hand movements can lead to complex and engrossing performances.

Many Theremins produce only simple tones but some Theremins – such as the unit described here – also allow adjustments to the tonal quality, so that the performance can be altered to suit the mood. Typically, the controls allow a range of sounds that can be varied between raspy-edged tones through to pure sinusoidal notes. The resulting sound can consist of smooth gliding tones (glissandi) or it can comprise separate notes (staccato) or a combination of both.

It really is a versatile instrument that is only limited by the skill of the player.

Controls

In order to play a Theremin, you must you must be able to accurately position your hands (and fingers) to produce the required tones. The more accurate a Theremin is in producing the same frequency (or tone) for a given hand position (ie, distance from the antenna), the easier it will be to play. Similarly, the volume control needs to produce a consistent effect in response to hand movements.

The SILICON CHIP Theremin Mk.2 has been designed to provide good consistency for both the pitch and volume "antenna controls". In addition, two external controls have been provided (on the front panel) to adjust the pitch (Pitch Range) and volume (Volume Span) settings. These are required to compensate for any changes that may occur over long periods of time or because of temperature changes.

The linearity of the response to hand movements is another critical feature when it comes to playing a Theremin easily. It is also critical to ensure the same range of hand movement for each octave and that none of the octaves are compressed into a tight range (which would make playing difficult).

As a result, this unit has been designed to provide excellent linearity when it is adjusted correctly. This has been made easier by a special test circuit that's used when setting up the Theremin Mk.2.

Tonal quality

Three further controls are included to adjust the tonal quality or "voice" of the Theremin. The most popular "voice" setting reproduces a cello sound at the lower frequencies, changing to a soprano voice at the upper frequencies. This tonal "voice" creates an interesting backdrop against other instruments, such as a piano or violin.

If you are interested in hearing some fine Theremin performances, log onto **http://www.peterpringle.com/thereminmp3s.html**.

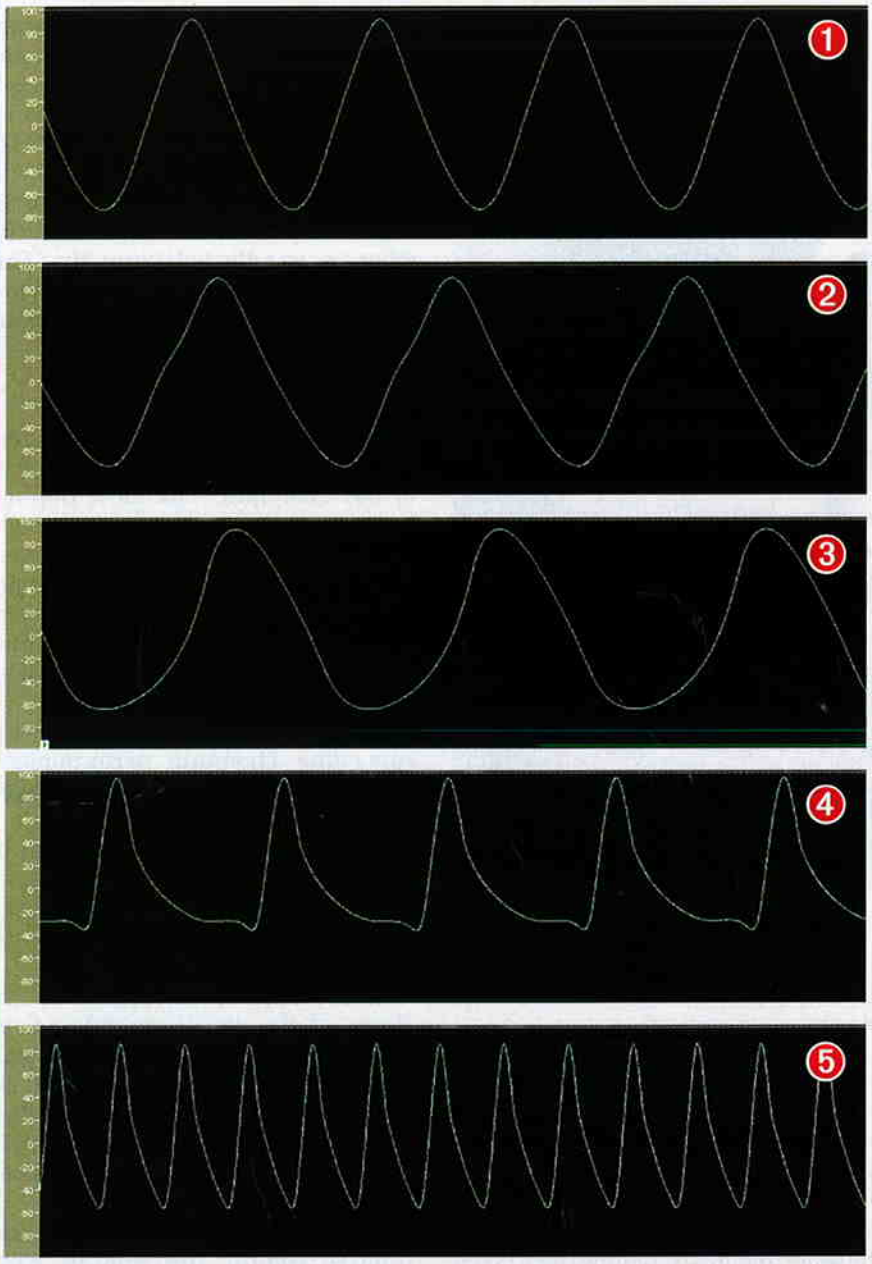
In operation, the "voicing" can be altered to suit using the Waveform, Symmetry and Skew controls. Each control produces its own characteristic variation in the sound.

The Waveform control varies the shape of the signal reproduced by the Theremin. At various settings, the unit produces waveforms that are somewhat triangular in shape, while at other settings it produces either squarer wave shapes or more sinusoidal waves.

Each wave shape has its own distinctive timbre, the squarer wave shapes producing a hollow sound similar to that produced by a reed instrument. The more triangular waveforms are less hollow, while the sinusoidal shapes gives a neutral or pure sound.

The Symmetry control varies the shape of the waveform below the horizontal centre line. You can vary the waveform shape so that it is symmetrical above and below the centre line or so that the lower half of the waveform becomes more rounded. This rounding produces a sound characteristic of a bowed instrument such as the cello.

Finally, the Skew control varies the waveform from being symmetrical



Above: these traces show the variety of waveforms that can be reproduced by the Theremin. The top four traces are all at 100Hz and show what can be done with just the waveform and symmetry controls, with the skew control set to minimum. Waveform 1 shows the output when the Theremin is set to produce a sinewave. The next waveform (2) is more distorted, with more triangle characteristics, while waveform 3 has a squarer wave shape. Waveform 4 shows what the skew control does to the signal at around 100Hz. As can be seen, it becomes very asymmetrical about the horizontal and vertical axis, exhibiting a more sawtooth wave shape. The final waveform (5) was obtained using the same settings that gave the waveform 4 but at a higher frequency of 250Hz, making it more sinusoidal in shape. This characteristic occurs for all waveform shapes at the higher frequencies. A filter adjustment sets the threshold point where the tone becomes more sinusoidal.

to asymmetrical (ie, more sawtooth in shape) about the vertical axis. An asymmetrical wave shape produces a brighter, richer sound.

Waveforms 1-5 show just some of the variety of waveforms that can be produced by the Theremin Mk.2.

Note that all three tonal controls interact with one another, so that a whole array of subtle sound variations can be reproduced. These variations in the sounds are due to the harmonic content of the waveform. A pure sine-wave comprises only the fundamental frequency and that is the only tone that you hear. If, for example, you play note A4, then you will hear a pure tone at 440Hz.

Waveforms that are not pure sine-waves include extra signals called harmonics. Harmonics are additional tones that are multiples of the fundamental frequency. So, for example, if you play note A4 again but produce a square wave, you will hear the fundamental 440Hz plus multiples of that frequency.

Square wave harmonics are always odd and so you will hear the third harmonic (3 x 440Hz or 1320Hz), the fifth harmonic at 2200Hz and the seventh and ninth harmonics, etc. Note that the harmonic signal level is lower than that of the fundamental and diminishes with increasing frequency. In fact, the third harmonic is one third the level of the fundamental, while the fifth harmonic is one fifth the level, etc.

Triangle waves also have only odd harmonics but the harmonic levels drop off much faster than the square wave harmonics. The third harmonic, for example, is only 1/9th the level of the fundamental and the fifth harmonic is 1/25th of the fundamental's level.

When the wave shape is skewed about the vertical axis to produce a sawtooth shape, or if the symmetry is altered about the horizontal axis, the harmonic content will include even and perhaps odd harmonics, depending on the waveform. Even harmonics are those that are twice the fundamental frequency, four times the fundamental, etc. These even harmonics give a stringed instrument sound effect and can enrich the sound produced by a square or triangle wave.

Gain control

The next control in the lineup is the Gain control. This is included to adjust the audio output level on the Theremin's line output socket. It basically allows the output level to be correctly adjusted in response to different wave shapes.

In practice, the line level output signal is fed out via a 6.35mm mono

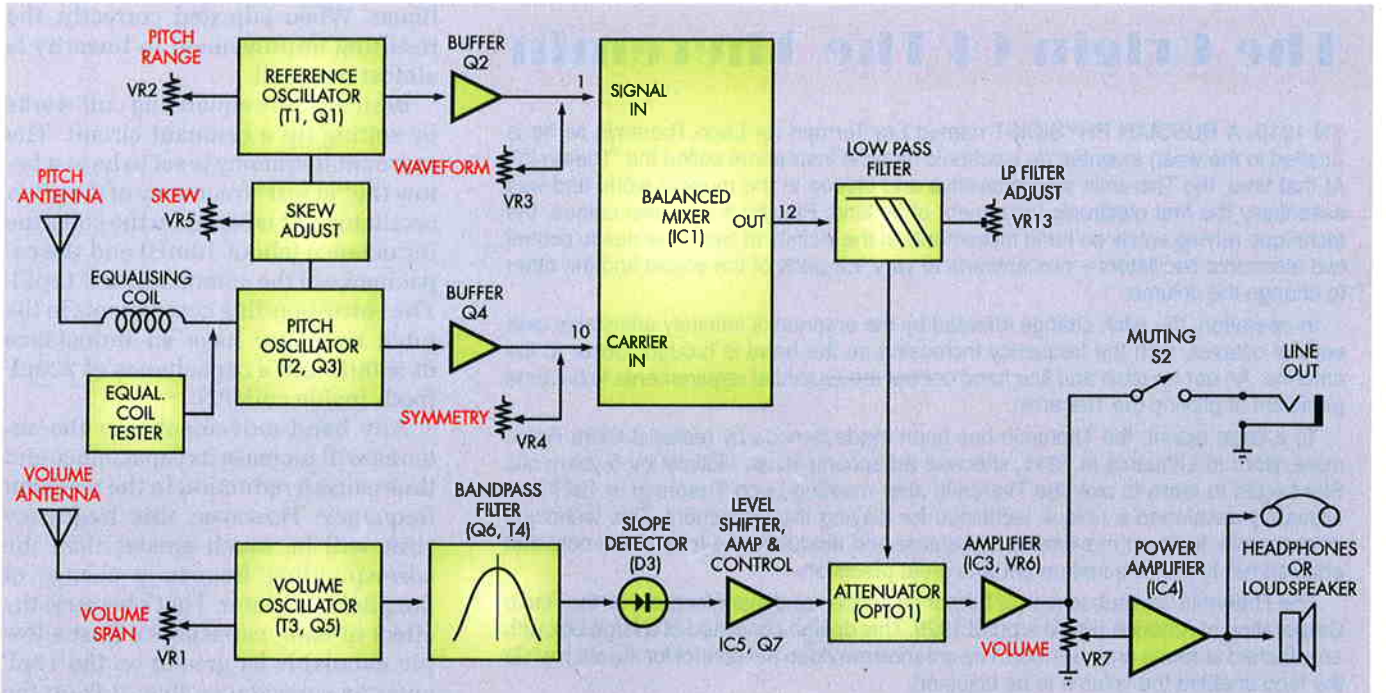


Fig.1: the Theremin is based on three virtually identical oscillators plus a balanced mixer (IC1). The mixer accepts the signals from the pitch and reference oscillators and generates difference signals to produce the tones. These are then fed to the output stages via a voltage-controlled attenuator stage.

jack socket. It can be switched on or off using the Muting switch.

Monitoring

Normally, you would use the line output from the Theremin to feed an external amplifier and loudspeakers. However, the unit also features an internal amplifier and loudspeaker, which can be used for practice sessions (or as a foldback monitor during live performances). A headphone socket is also provided and this automatically disconnects the internal loudspeaker when the headphones are plugged in.

Presentation

As shown in the accompanying photos, the SILICON CHIP Theremin Mk.2 is housed in a plastic case which in turn is mounted on a small camera tripod which serves as a desk stand. The pitch antenna sits vertically in the rear righthand corner of the box, while the volume antenna lies nearly horizontally on the lefthand side of the box.

The various controls are arranged along the front face of the box, while the line output, headphone and DC supply sockets are located on the righthand side of the box, along with the power switch and a muting switch.

Power for the circuit comes from a DC plugpack.

Block diagram

OK, let's now take a look at how the unit works. We'll start with the block diagram which is shown in Fig.1.

A balanced mixer (IC1) is at the heart of the operation. This accepts two signals: one from a reference oscillator (based on coil T1 and Mosfet Q1) and the second from a pitch oscillator (based on coil T2 and Mosfet Q3). The latter's frequency is controlled using the pitch antenna, which is connected to the oscillator via an equalising coil.

Typically, both the reference oscillator and the pitch oscillator are set to the same frequency, at about 455kHz. Any movement of the hand near to the pitch antenna will then alter its capacitance to ground and change the pitch oscillator's frequency.

In operation, the mixer produces several signals, depending on the incoming signals from the reference and pitch oscillators. These signals are: (1) the original reference oscillator signal (455kHz); (2) the sum of the reference and pitch oscillator frequencies; and (3) the difference between the pitch and reference oscillator frequencies.

When the two oscillators are at the same frequency (eg, 455kHz), then the sum of the two frequencies will be 910kHz while the difference frequency will be close to zero. The mixer's output is then fed to a low-pass filter which has a cutoff frequency of 3kHz. As a result, the 455kHz and 910kHz signals are filtered out, leaving only the difference signal.

In this case, however, there will be no output since the difference signal is zero. However, when the pitch oscillator's output frequency is lowered by moving the hand closer to the pitch antenna, the difference between the reference and pitch oscillators increases and we get an audible output. The lower the pitch oscillator's frequency, the greater the difference frequency from the mixer and the higher the tone fed to the amplifier stages.

For example, if the pitch oscillator is reduced to 454kHz, the difference frequency will be 1kHz and so we get a 1kHz audio output from the low-pass filter. If it goes down to 453kHz, we get a 2kHz audio output signal.

In practice, the difference signal from the mixer ranges in frequency from 65.4Hz to 2093Hz, which is equivalent to five octaves.

Equalising coil

The equalising coil in series with

The Origin Of The Theremin

IN 1919, A RUSSIAN PHYSICIST named Lev Termen (or Leon Theremin as he is called in the west) invented an electronic musical instrument called the "Theremin". At that time, the Theremin was innovative and unique in the musical world and was essentially the first electronic instrument of its kind. Playing it was also unique, the technique relying solely on hand movements in the vicinity of two antennas to control two electronic oscillators – one antenna to vary the pitch of the sound and the other to change the volume.

In operation, the pitch change afforded by the antenna is infinitely adjustable over several octaves, with the frequency increasing as the hand is brought closer to the antenna. An ear for pitch and fine hand control are essential requirements to become proficient at playing the Theremin.

To a large extent, the Theremin has been made famous by recitalist Clara Rockmore. Born in Lithuania in 1911, she was an accomplished violinist by 5-years old. She began to learn to play the Theremin after meeting Leon Theremin in 1927 and ultimately developed a unique technique for playing the instrument. This technique involved minute finger movements to capture and modulate the tone of the note and enabled her to play the instrument with great precision.

The Theremin was subsequently further developed and manufactured by the Radio Corporation of America (RCA) around 1929. This design consisted of a large box with an attached antenna and wire loop. The antenna provided the control for the pitch while the loop enabled the volume to be adjusted.

In practice, the pitch control antenna was mounted vertically while the volume loop sat horizontally, to minimise interaction between them. And of course, the circuit used valves.

General Electric (GE) and Westinghouse also made Theremins in the 1920s. However, the number of units produced was quite modest, with only about 500 units being made.

Today, the Theremin is hailed as the forerunner to modern synthesised music and was instrumental in the development of the famous Moog synthesisers. Because of its unique sound, it has been popular with music producers for both film and live performances. For example, is was used to produce background music in "The Ten Commandments" feature film by Cecil B DeMille. Its eerie sounds have also made it ideal for science fiction movies, including "The Day the Earth Stood Still" and " It Came From Outer Space", and in thriller movies such as "Spellbound" and "Lost Weekend".

In addition, Bands such as the Bonzo Dog Band and Led Zeppelin have embraced the Theremin. The Beach Boys used an instrument similar to the Theremin – called an Electro-Theremin (also named a Tannerin) – in their famous "Good Vibrations" hit from the 1960s. The Electro-Theremin differs from the Theremin in that it incorporates a mechanical controller to adjust the pitch rather than hand movements relative to an antenna.

Many commercial Theremins are available on the market today, including the Etherwave series from Moog Music Inc, PaiA's Theremax and Wavefront's Classic and Travel-Case Theremins. SILICON CHIP has also published two previous designs for home construction – ie, a basic Theremin in August 2000 and a MIDI Theremin in April and May 2005.

the pitch antenna vastly improves the linearity of any frequency changes with hand movement. Without it, these frequency changes would be very non-linear – very large hand movements would be required to produce pitch changes at the low-frequency end, while only minute hand movements would be required at the high-frequency end.

This "compression" of the frequency range for hand positions close to the antenna is due to the way a tuned circuit works. The variations in capacitance with hand movement are linear with the distance from the antenna. However, the frequency of a tuned circuit is inversely proportional to the square root of the capacitance. As a result, greater pitch variations occur for a given hand movement the closer we get to the antenna.

Adding the equalising coil has the effect of reducing the hand movements required for the lower octaves and increasing the hand movements required for the upper octaves, so that the overall response is much more linear. When adjusted correctly, the resulting improvement in linearity is almost magical!

Basically, the equalising coil works by setting up a resonant circuit. The resonant frequency is set to be just below the "at rest" frequency of the pitch oscillator and is based on the coil's the inductance (about 10mH) and the capacitance of the antenna (about 12pF). The corresponding components in the pitch oscillator have an inductance of 560µH and a capacitance of 220pF (both inside coil T2).

Any hand movement near the antenna will increase its capacitance and thus cause a reduction in the resonant frequency. However, this frequency shift will be much greater than the corresponding frequency change of the pitch oscillator. That's because the effect of hand capacitance (just a few picofarads) is far greater on the 12pF antenna capacitance than it is on the much larger 220pF capacitor in parallel with the pitch oscillator coil.

The overall effect is that your hand has a progressively smaller effect on the pitch oscillator as it is brought closer to the antenna. This introduced non-linearity counteracts the inherent non-linearity of the pitch oscillator and makes pitch changes much more linear for given hand movements.

Waveform shaping

The wave shape of the output is controlled using the Waveform, Symmetry and Skew potentiometers (VR3-VR5). Both the Waveform and Symmetry controls work by changing the DC bias levels on both the signal and carrier inputs of the mixer. A different bias voltage affects the wave shape that's applied to a particular input of the mixer and this changes the resulting output waveform.

Note that buffer stages (Q2 & Q4) are included in series with the outputs of the reference and pitch oscillators before the signal is applied to the mixer. These isolate the oscillators from the DC bias voltages at the mixer inputs, to prevent unwanted changes to the oscillator frequencies.

The Skew adjustment varies the coupling between the pitch and reference oscillators, in turn varying their tendency to lock to the same frequency. When both oscillators are running close to the same frequency, increasing the skew control will cause the two oscillators to lock and so their

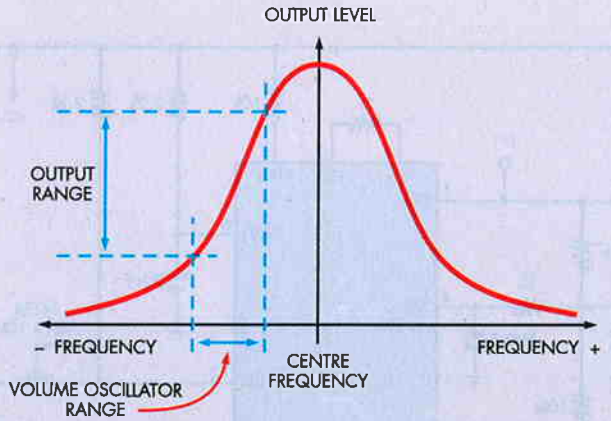


Fig.2: this graph shows the response of the bandpass filter. It reduces the signal level as the frequency of the volume oscillator decreases.

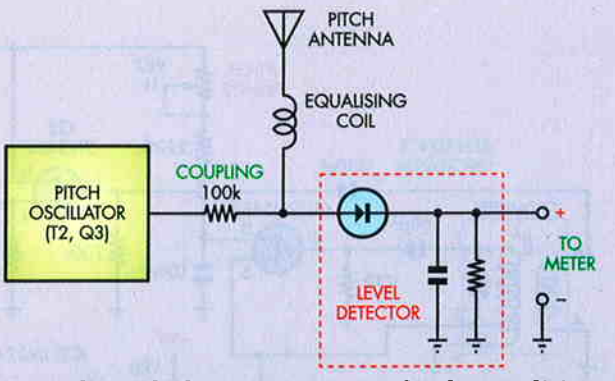


Fig.3: this is the basic arrangement for the equalising coil tester. It allows the pitch oscillator to be correctly adjusted so that the equalising coil and pitch antenna resonate, as indicated by a voltage dip on the output meter.

output frequencies will be the same. However, if extra hand capacitance forces the pitch oscillator to change, it will suddenly "snap" to a different frequency. At the same time, the reference oscillator will continue to have an affect and so the resulting output waveform from the mixer will be skewed.

Low-pass filter

As mentioned, the adjustable low-pass filter following the mixer output removes the higher frequencies from the mixing process, leaving only the difference frequency. Its frequency of roll-off can be varied from 3.3kHz down to 592Hz, depending on the effect required.

Following this filter, the signal is fed to an attenuator and then to amplifier stage IC3. This stage has a gain of between two and seven, depending on the setting of gain control VR6.

The output from IC3 then goes to the Line Out socket via Muting switch S2. It also goes to power amplifier IC4 via volume control VR7. The power amplifier then drives an internal loudspeaker or a pair of headphones.

Volume control oscillator

The volume oscillator is based on transistor Q5 and transformer coil T3. As with the pitch oscillator, its frequency varies in response to hand movement.

In operation, its frequency reduces as the hand is brought closer to the volume antenna. The resulting signal is then fed to a bandpass filter that rolls off signals above and below its centre frequency. Fig.2 shows the response shape of this bandpass filter.

The bandpass filter is set so that its centre frequency is above the frequency range of the volume oscillator – ie, the frequency of the volume oscillator is to the left (or lower frequency side) of the peak in the filter response curve. Therefore, as the oscillator's frequency decreases, the filter reduces the signal level.

The output from the bandpass filter is fed to a slope detector based on diode D3. This converts the signal to a DC voltage which is then applied to a level-shifting amplifier based on IC5. Its output in turn controls the audio attenuator stage.

Equalising coil tester

Finally, we come to the equalising coil tester which is attached to the pitch oscillator. This tester allows the equaliser coil to be checked with the pitch oscillator, to verify that its value is correct. Fig.3 shows the basic arrangement.

In operation, the pitch oscillator's output is lightly coupled to the pitch antenna via the equalising coil. The oscillator frequency is then is adjusted until the following level detector circuit detects the resonance, as indicated by a voltage dip on the meter.

Circuit details

OK, that covers the basics. Now let's take a look at the complete circuit diagram – see Fig.4.

The first thing to note is that all three oscillators (Reference, Pitch and Volume) are virtually identical. Each oscillator is based on a junction FET (Q1, Q3 & Q5) and a standard IF (intermediate frequency) transformer coil (T1-T3), as used in low-cost AM radio tuners.

Each transformer includes a tapped primary winding and a parallel-connected capacitor to form a tuned circuit. Its corresponding JFET drives a portion of the primary winding (ie, between the pin 2 tap connection and ground), while the signal at the top of the primary is coupled to the gate (which is self-biased) via a 68pF capacitor.

This arrangement provides positive feedback to maintain oscillation at the tuned frequency.

In the case of the reference oscillator, transformer T1 is tuned to produce an output frequency of about 455kHz. Power for the circuit comes from a +8V rail and this is applied to Q1's drain via potentiometer VR2 and a 220Ω resistor. VR2 provides pitch adjustment by varying the drain to source current flow through Q1. This alters the gate-to-source voltage and thus Q1's gate-to-source capacitance. And this in turn alters the tuned frequency.

T1's secondary winding at pins 4 & 6 provides a low impedance output from the oscillator. This output is then further buffered using an amplifier stage based on JFET Q2 which is configured as a source follower. This buffering is essential to isolate the oscillator from the following stages, so that it is immune to any capacitance changes caused by varying the bias levels at the inputs to IC1.

The pitch oscillator is almost identical, the main difference being the use of a fixed 680Ω resistor in Q3's drain circuit. In addition, the pitch antenna

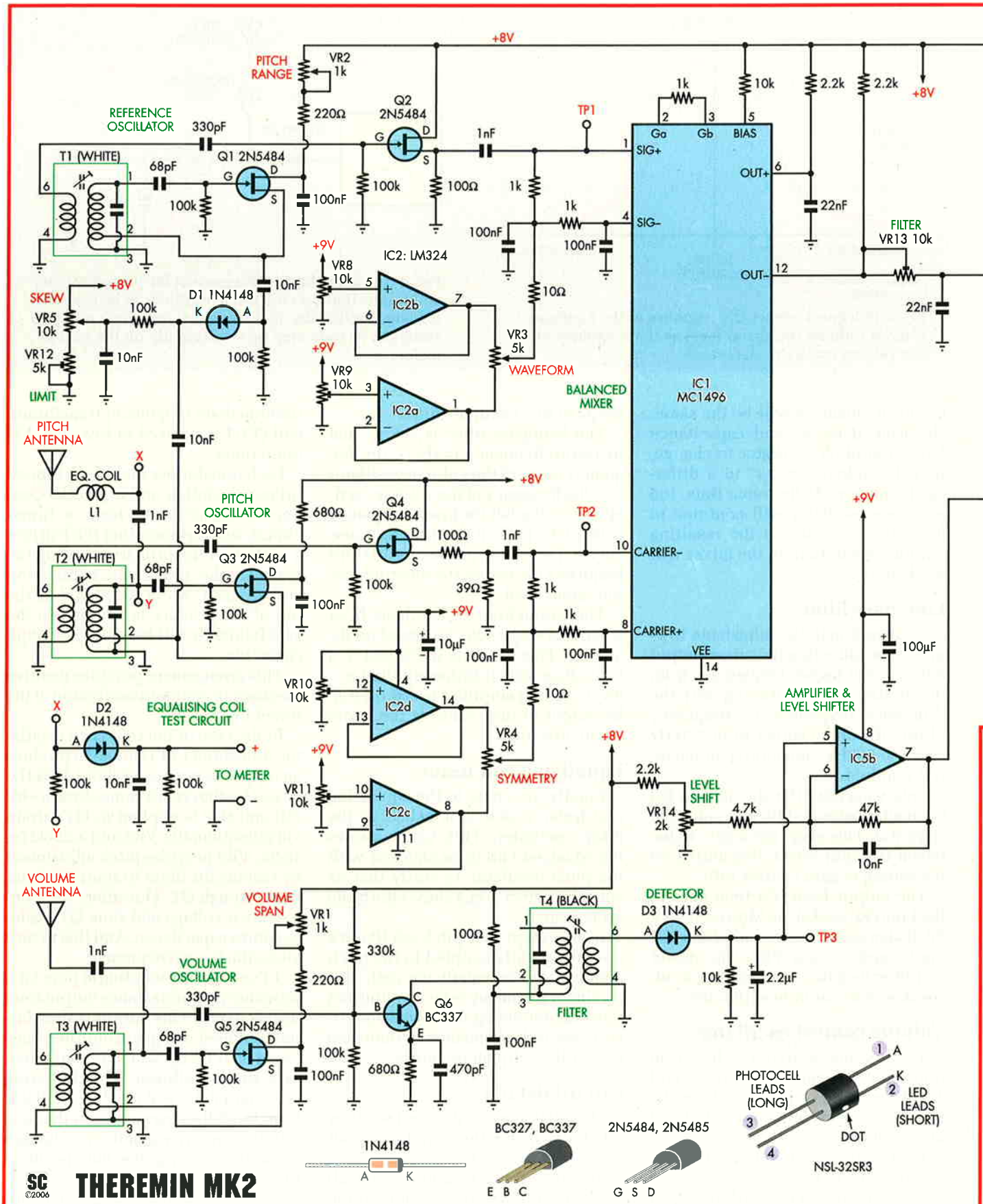
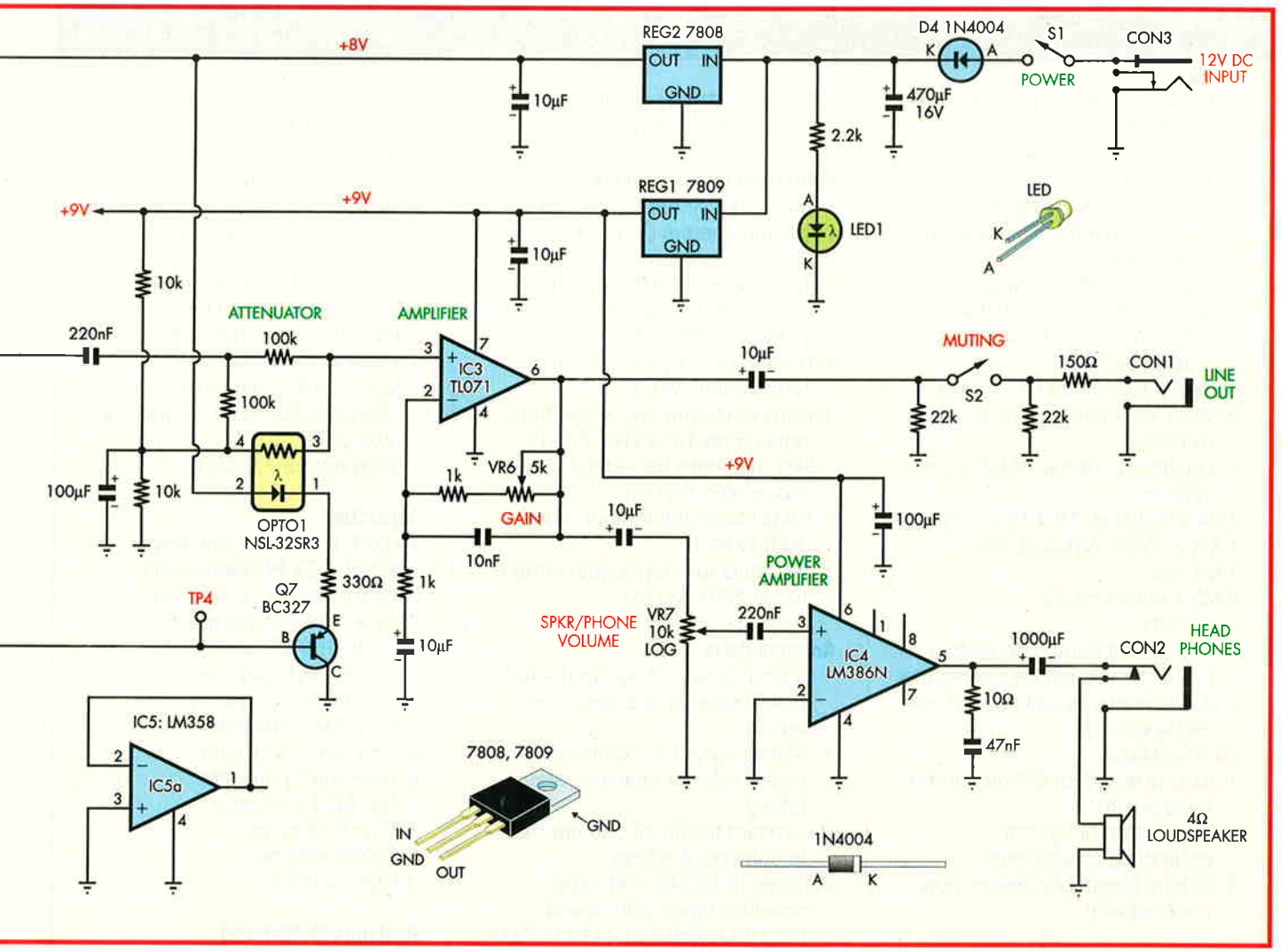


Fig.4: the complete circuit for the Theremin Mk.2. Each oscillator is based on a junction FET (Q1, Q3 & Q5) and a standard IF transformer coil (T1-T3). IC1 is the balanced mixer – it produces the difference signal and feeds this to the audio output stages via an attenuator (OPTO1), in turn controlled by the volume oscillator and its following stages.



is connected to pin 1 of transformer T2 via a 1nF capacitor and the equalising coil (L1).

The equalising coil test circuit is also attached to this part of the oscillator circuit during testing. In this case, the oscillator signal at pin 1 of transformer T2 (marked "Test") is coupled into the pitch antenna via a 100kΩ resistor. This resistor ensures only minimal loading of the equalising coil and antenna tuned circuit.

Diode D2 and the 10nF capacitor form a peak detector and this allows us to measure the relative level of the signal across the equalising coil and pitch antenna. The associated 100kΩ resistor across the 10nF capacitor helps to discharge the capacitor, so that the voltage on D2's cathode drops with decreasing signal level.

In practice, the ferrite slug inside T2 is adjusted so that pitch antenna and equalising coil resonate. We'll describe how this is done in Pt.2.

The volume oscillator is similar to the pitch oscillator but also includes a variable drain supply. This is provided by potentiometer VR1, which is the volume range (or volume span) adjustment. The volume antenna is connected to pin 1 of T3 via a 1nF capacitor.

Mixer

The reference and pitch oscillator signals from buffer stages Q2 and Q4 are applied via 1nF capacitors to pins 1 (signal) and 10 (carrier) of IC1 respectively. However, the signal applied to the carrier input is reduced to around 50mV using a resistive divider at the source of Q4. This reduction in signal level is necessary to prevent overloading the mixer stages of IC1.

IC1's signal inputs at pins 1 & 4 and its carrier inputs at pins 8 & 10 are biased using potentiometers VR3 and VR4 respectively. Note, however, that any signal applied to pins 4 and 8 is shunted to ground via 100nF capacitor. In other words, these pins are simply DC biased.

The DC bias range provided by VR3 & VR4 is set by the outputs of buffer stages IC2a-IC2d. These op amps are all wired as voltage followers and each buffers a sampled voltage from the +9V rail, as set by trimpots VR8-VR11.

In effect, each buffer pair sets the maximum and minimum bias voltages and applies these to its corresponding potentiometer (VR3 & VR4). This ensure that VR3 and VR4 only provide the range of control that is necessary to produce the varied waveforms.

A 1kΩ resistor between pins 2 and 3 of IC1 sets the gain of the mixer, while the bias voltage at pin 5 sets output signal level. The balanced mixer outputs appear at pins 6 and 12.

Each output is biased on using 2.2kΩ pull-up resistors and is filtered to remove the high-frequency components. The output at pin 6 has a fixed

Parts List

1 PC board coded 01207061, 188 x 103mm
1 plastic UB2 utility case, 197 x 113 x 63mm
1 12V DC 450mA plugpack
1 190 x 105mm aluminium sheet (1mm thick)
1 100mm 4Ω 2W loudspeaker
2 high-quality stereo switched 6.35mm jack sockets, PC-mount (Jaycar PS-0195)
1 2.5mm PC-mount DC socket
2 SPST ultra-mini rocker switches (S1,S2)
1 mini tripod (Jaycar AM-4112 or similar)
1 mini heatsink, 19 x 19 x 10mm
1 M4 x 25mm Nylon screw
1 M4 nut
9 M3 x 6mm screws
9 M3 nuts
3 4mm eyelet crimp connectors
4 4.8mm female spade connectors
7 plastic knobs to suit (do not use metal knobs)
20 PC stakes
1 400mm length of 0.7mm tinned copper wire
1 2.5m length of 0.5mm enamelled copper wire
1 250mm length of medium duty hook-up wire

Transformers and ferrites

2 pot cores, 26 x 11.5 x 8mm (Al of 4740) (Jaycar Cat. LF-1060 or equivalent) (L1)
1 bobbin to suit above cores (Jaycar Cat. LF-1062 or equivalent)
3 low-cost 455kHz 2nd IF transformers (white slug)
1 low-cost 455kHz 3rd IF transformer (black slug)

Potentiometers & trimpots

2 16mm 1kΩ linear PC-mount potentiometers (VR1,VR2)
3 16mm 5kΩ linear PC-mount potentiometers (VR3,VR4,VR6)
1 16mm 10kΩ linear PC-mount potentiometer (VR5)
1 16mm 10kΩ log PC-mount potentiometer (VR7)
4 10kΩ multi-turn top-adjust trimpots (code 103)(VR8-VR11)
1 5kΩ multi-turn top-adjust trimpot (code 503) (VR12)
1 10kΩ horizontal trimpot (code 103) (VR13)
1 2kΩ multi-turn top-adjust trimpot (code 203) (VR14)

Antenna Parts

1 375mm length of 16mm diameter plated steel or stainless steel tubing
1 125mm length of 16mm diameter plated steel or stainless steel tubing
2 chromed towel rail end brackets to suit above tubing
2 16mm ID plastic end caps
1 miniature tripod with ¼-inch mount (Jaycar AM-4112 or AM-4110)
2 M4 x 10mm screws
2 M4 x 15mm screws
4 M4 nuts
1 ¼-inch Tee nut

Semiconductors

1 MC1496 balanced modulator (IC1)
1 LM324 quad op amp (IC2)
1 TL071 JFET input op amp (IC3)
1 LM386 1W power amplifier (IC4)
1 7809 9V 1A regulator (REG1)
1 7808 8V 1A regulator (REG2)
5 2N5484 or 2N5485 JFETs (Q1-Q5)
1 BC337 NPN transistor (Q6)
1 BC327 PNP transistor (Q7)
3 1N4148 diodes (D1-D3)
1 1N4004 1A diode (D4)
1 NSL-32SR3 optocoupler (Silonex) (OPTO1) Farnell Cat. 369-2218
1 5mm red LED (LED1)

Capacitors

1 1000µF 16V PC electrolytic
1 470µF 16V PC electrolytic
3 100µF 16V PC electrolytic
7 10µF 16V PC electrolytic
1 2.2µF 16V PC electrolytic
1 220nF MKT polyester
8 100nF MKT polyester
1 47nF MKT polyester
2 22nF MKT polyester
6 10nF MKT polyester
4 1nF MKT polyester
1 470pF ceramic
3 330pF ceramic
3 68pF ceramic

Resistors (0.25W 1%)

1 330kΩ	2 680Ω
10 100kΩ	1 330Ω
1 47kΩ	2 220Ω
2 22kΩ	1 150Ω
4 10kΩ	3 100Ω
1 4.7kΩ	1 39Ω
4 2.2kΩ	3 10Ω
6 1kΩ	

low-pass filter consisting of a 22nF capacitor to ground. By contrast, the output at pin 12 is connected to an adjustable low-pass filter consisting of VR13 and a 22nF capacitor. As stated previously, its roll-off frequency can be continuously adjusted from 3.3kHz (VR13 set to 0Ω) down to 592Hz (VR2 at 10kΩ).

Volume control

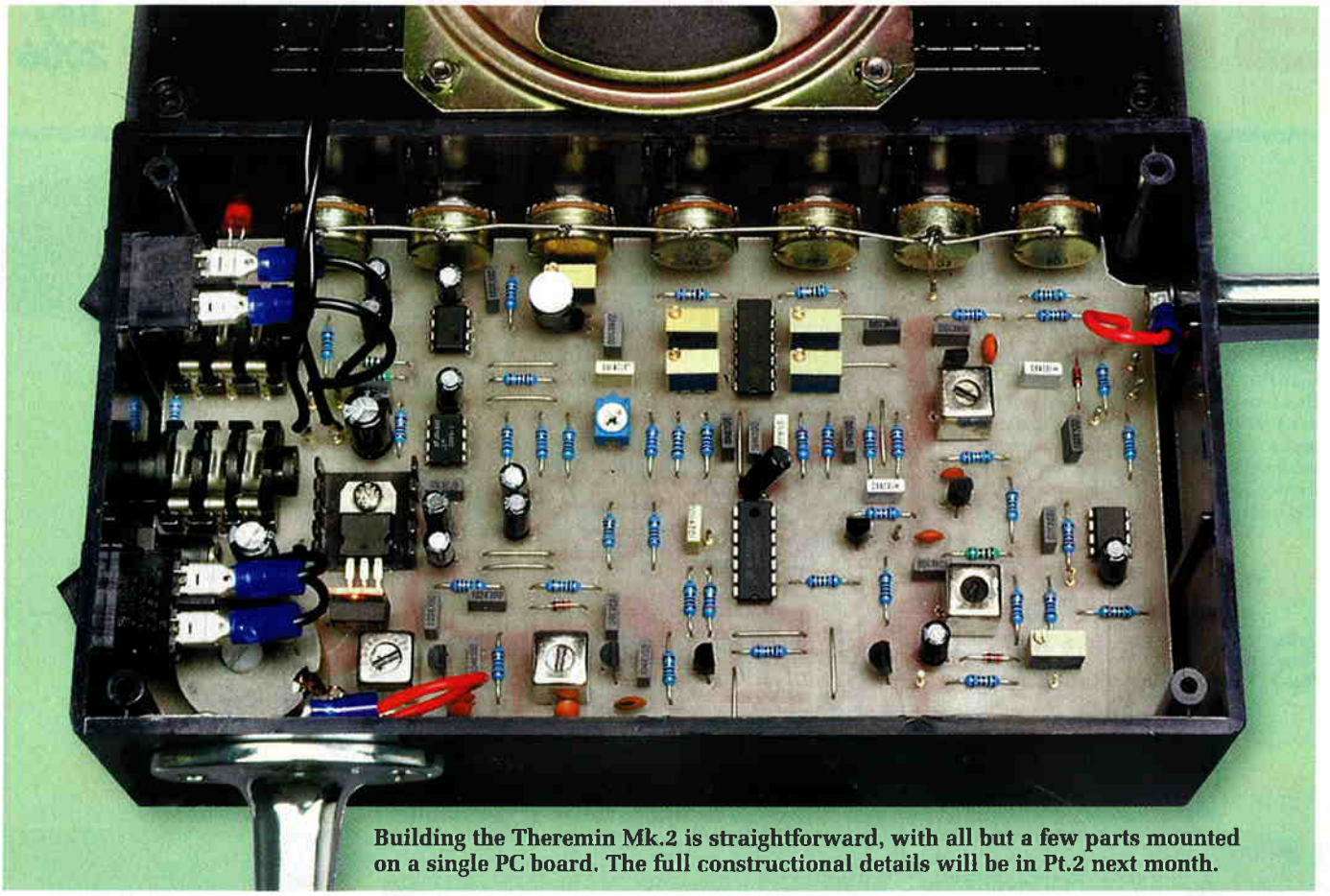
Following the low-pass filter, the signal is AC-coupled to a 100kΩ resistor in series with the pin 3 input of amplifier stage IC3. This input is biased to 4.5V via the 10kΩ voltage divider resistors across the 9V supply and a second 100kΩ resistor. This allows the op amp to produce a symmetrical output voltage swing before clipping. The 4.5V bias supply is decoupled using a 100µF electrolytic capacitor to remove any signal ripple.

The signal level applied to pin 3 of IC3 is controlled by OPTO1 which is an opto-coupled LDR (light dependent resistor). This in turn is controlled by the volume oscillator and its following circuitry. As shown, the LDR is connected between pin 3 of IC3 and the 4.5V rail.

Normally, the LDR has negligible effect on the signal since its resistance is considerably higher than the 100kΩ resistor at pin 3 of IC1. However, when current flows through the LED in OPTO1, the resistance of the LDR falls. This shunts signal from pin 3 to the 4.5V rail.

In operation, the LDR has a resistance range from about 25MΩ down to 60Ω, giving an attenuation range from 0db to -64dB.

As discussed previously, hand movements over the volume antenna control the amount of attenuation. It works as follows. First, the signal from the volume oscillator (T3 & Q5) is fed to



Building the Theremin Mk.2 is straightforward, with all but a few parts mounted on a single PC board. The full constructional details will be in Pt.2 next month.

the bandpass filter which is based on transistor Q6 and tuning coil T4. T4 is tuned so that the output signal at its pin 6 decreases in level as the volume oscillator frequency decreases (ie, as the hand moves closer to the volume antenna).

Diode D3 rectifies this signal and its output is filtered using a 2.2µF capacitor to provide a DC voltage. The associated 10kΩ resistor across the capacitor provides a discharge path, thus allowing the voltage across the capacitor to fall if the signal level falls.

This voltage is fed to IC5b which is wired as a non-inverting amplifier and level shifter. Trimpot VR14 adjusts the output offset of the amplifier, so that it can be set to vary from about 8V down to nearly 0V with hand movement.

IC5b's output appears at pin 7 and drives PNP transistor Q7 which is wired as an emitter follower. This in turn drives the LED within OPTO1 via a 330Ω resistor. The anode side of the LED is connected to the 8V supply.

Note that there are two supply rails – ie, 8V and 9V. Op amp IC5 is powered from the 9V supply while the LED is powered from the 8V supply. The 1V extra for the op amp is to ensure that IC5b's output can swing high enough to switch Q7 and the LED fully off.

Power amplifier IC4 is also powered from the 9V rail while the more "voltage sensitive" sections of the circuit are powered from the 8V rail. This separation of supply rails ensures that IC4 can drive the loudspeaker at full power without affecting other parts of the circuit.

Op amp IC3 buffers the attenuated signal and also provides gain that can be varied from 2-7, depending on the setting of Gain control VR6. The 10nF capacitor between pins 2 & 6 rolls off high frequencies to prevent instability.

IC3's output appears at pin 6 and is AC-coupled to mute switch S2 in series with the line output socket (CON1). The series 150Ω resistor serves to isolate IC3's output from the load connected to the line out.

IC3's output is also fed to volume control VR7 via a 10µF capacitor. From there, the signal goes to pin 3 of power amplifier IC4 via a 220nF capacitor. IC4 then drives the Theremin's loudspeaker or a pair of headphones via a 1000µF capacitor and connector CON2. Plugging the headphones into CON2 automatically disconnects the loudspeaker.

Note that a Zobel network comprising a 10Ω resistor and 47nF capacitor is connected across IC4's output. This is done to prevent oscillation in the amplifier.

Power supply

Power for the circuit is derived from a 12V DC plugpack. This is fed in via power switch S1 and diode D4 which provides reverse polarity protection. LED 1 provides power on/off indication, while a 470µF electrolytic capacitor filters the supply rail before it is applied to 3-terminal regulators REG1 and REG2.

REG1 and REG2 respectively provide the regulated +9V and +8V supply rails. Their outputs are decoupled using 10µF capacitors.

That's all we have space for this month. Next month, we will give the full construction details and describe the setting-up and adjustment procedures. **SC**

DSE

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Great for jobs around your home or office, this 4.8V rechargeable cordless screwdriver uses a durable metal gearbox and strong moulded body for longer life. Forward/reverse control, 3-4hr mains charger, accessory bits and instructions. **T 4844**

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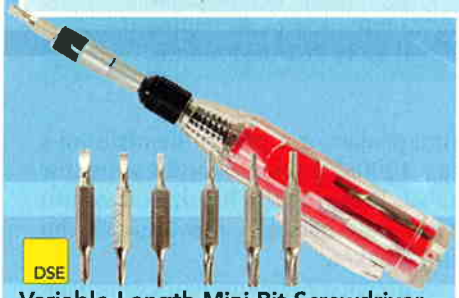

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5pcs bits are held inside the screwdriver body in a rotary holder, handy adjustable shaft feature (55mm to 110mm long), 6pcs mini-size bits supplied. **T 6335**

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With a 13mm display, 200mV full scale input sensitivity and single 9V DC operation. Decimal point selectable, automatic polarity indication, guaranteed zero reading for 0V input. High input impedance > 100MΩ. Easy bezel fixing method. **Q 2220**

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This precision soldering station provides huge 100W power for fast heat-up and recovery while maintaining tip temperature within +/- 3°C. Ideal for use with lead-free solder, this high power soldering station uses a lightweight soldering pencil with a ceramic heater element and integral temperature sensor for fast heat-up and temperature control responses. It's supplied with a plated and pre-tinned 1.6mm tip and uses burn-resistant cable between the soldering pencil and the soldering station for added safety. An in-built Energy Saver circuit extends tip life by cutting power consumption in half if the station has been idle for 15 mins, with the slightest motion of the soldering pencil activating the heater and very quickly returning the tip to its preset temperature. For added safety, the heater element is isolated from the mains by a 32V AC output transformer, and zero-voltage switching is used to help protect any sensitive circuitry you may be working on. The tip temperature is adjustable between approx 200°C and 450°C, and a bright LED display clearly shows the current temperature in either °C or °F. Supplied complete with a soldering iron stand and brass shavings tip cleaner. **T 2260**

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Suits P 1834 Line Socket.
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1mm diameter, 100g roll.
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Uses light, touch and other sensors to activate output motors. Program the microcomputer via your PC to execute complicated manoeuvres. K 1488

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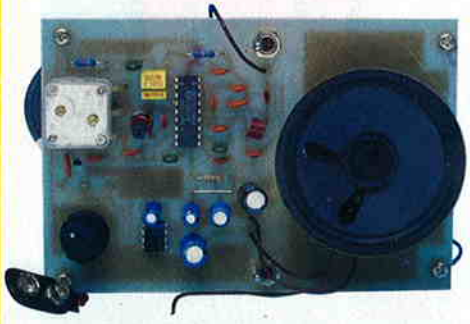

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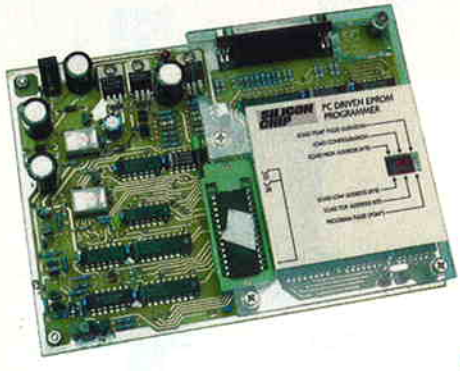

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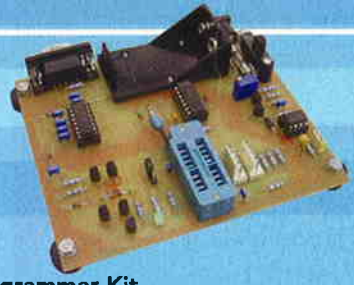

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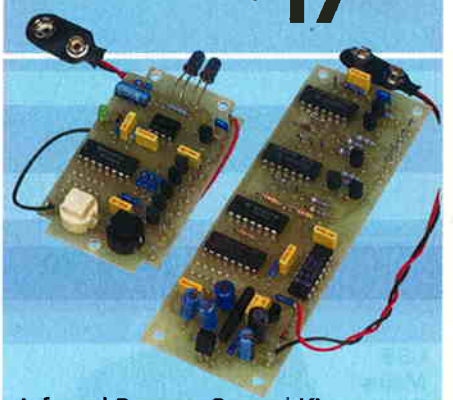

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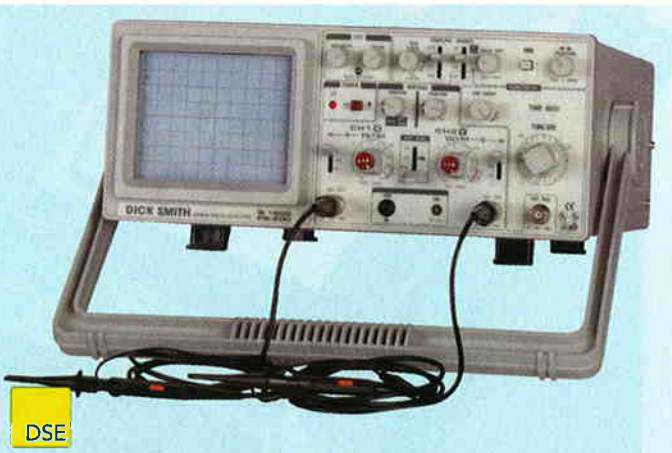

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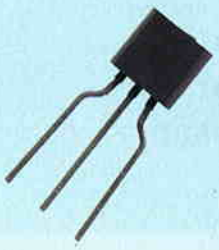

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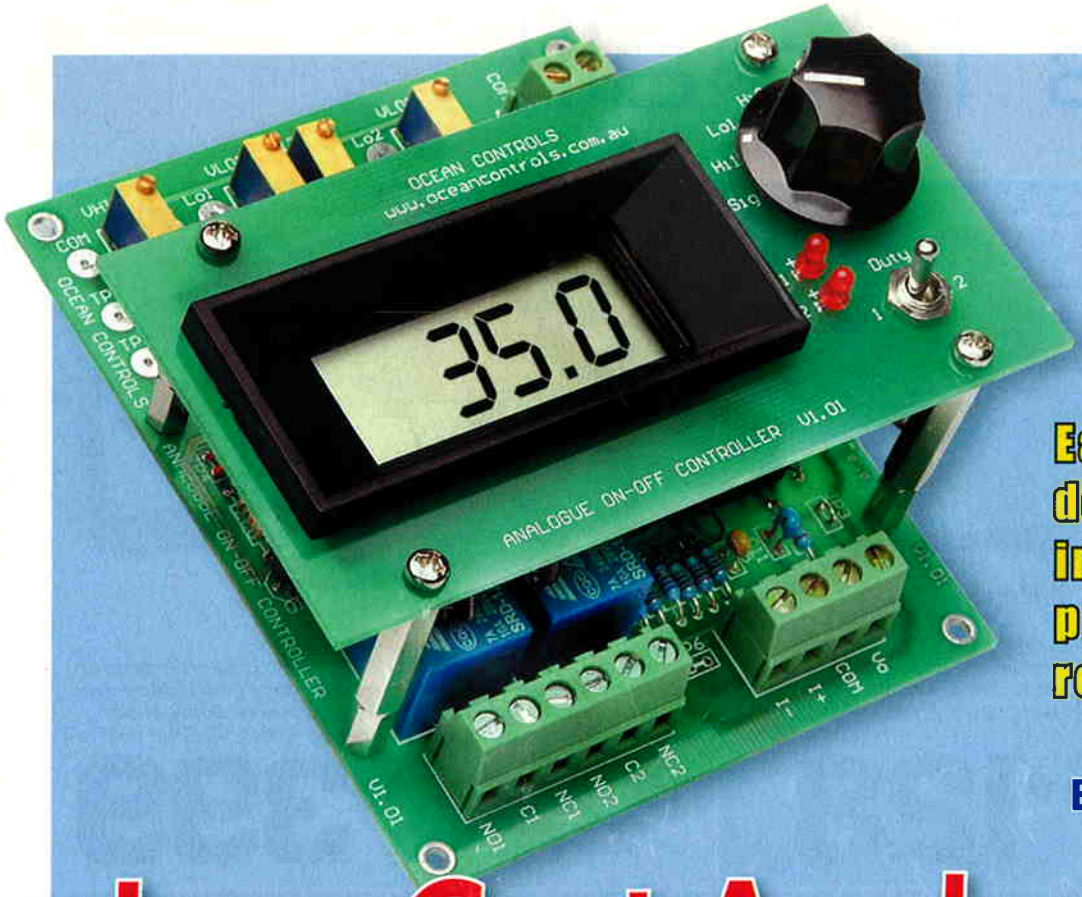


Easy-to-build design has two independently programmable relay outputs

By GREG RADION

Low-Cost Analog On-Off Controller

Have you ever wanted to control a device based on an analog signal level? Perhaps you want to fill a water tank automatically or control exhaust fans based on humidity or temperature. Well now, you can – provided you have a sensor that gives an analog voltage or current output.

This Analog On-Off Controller unit switches two independent relays based on the signal level at its input. The "on" and "off" levels for each relay are easily set using only a screwdriver and you can monitor the level of the signal on an LCD panel meter if desired.

With its fully adjustable design, the controller accepts inputs in the range of 0-10V or 0-20mA. Its current input capability also means that it can be used with industrial sensors that provide a 4-20mA current loop interface.

Best of all, this unit can be put together for about $65.00 and is very easy to build. All the parts are mounted on two PC boards which are stacked together and connected using rainbow cable.

How it works

The Analog On-Off Controller is essentially a group of voltage comparators with additional circuitry to translate input signals to a usable voltage range, as well as flipflops to hold the two outputs in their last "on" or "off" state.

The complete circuit for the controller appears in Fig.1. Apart from op amp IC1 and relays REL & REL2, the circuit is powered via a 7805 +5V regulator (VREG1). Diode D1 is included in series with the 12V input to protect against supply polarity reversal.

An LT1014 precision op amp (IC1c) buffers the input signal. This op amp

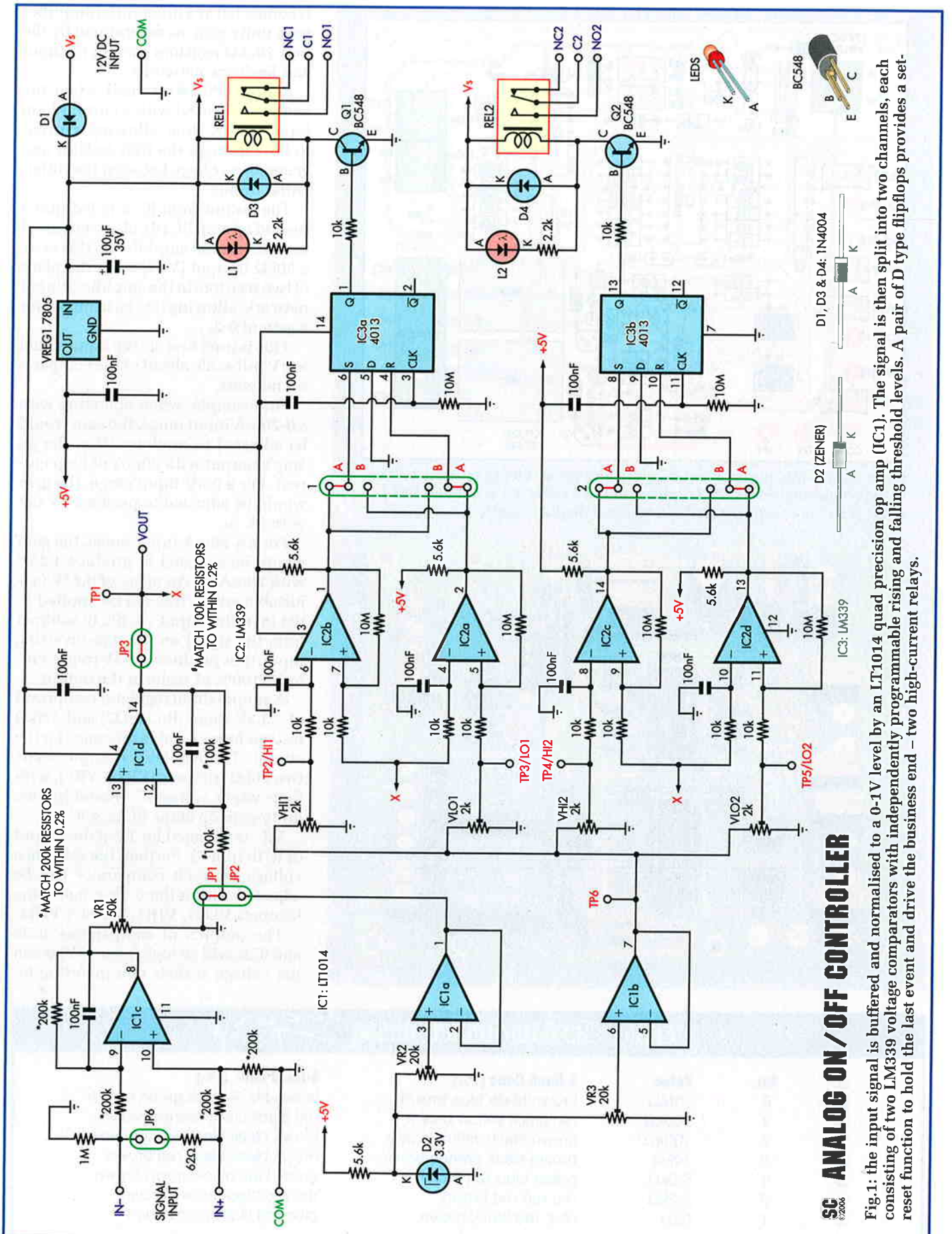


Fig.1: the input signal is buffered and normalised to a 0-1V level by an LT1014 quad precision op amp (IC1). The signal is then split into two channels, each consisting of two LM339 voltage comparators with independently programmable rising and falling threshold levels. A pair of D type flipflops provides a set-reset function to hold the last event and drive the business end – two high-current relays.

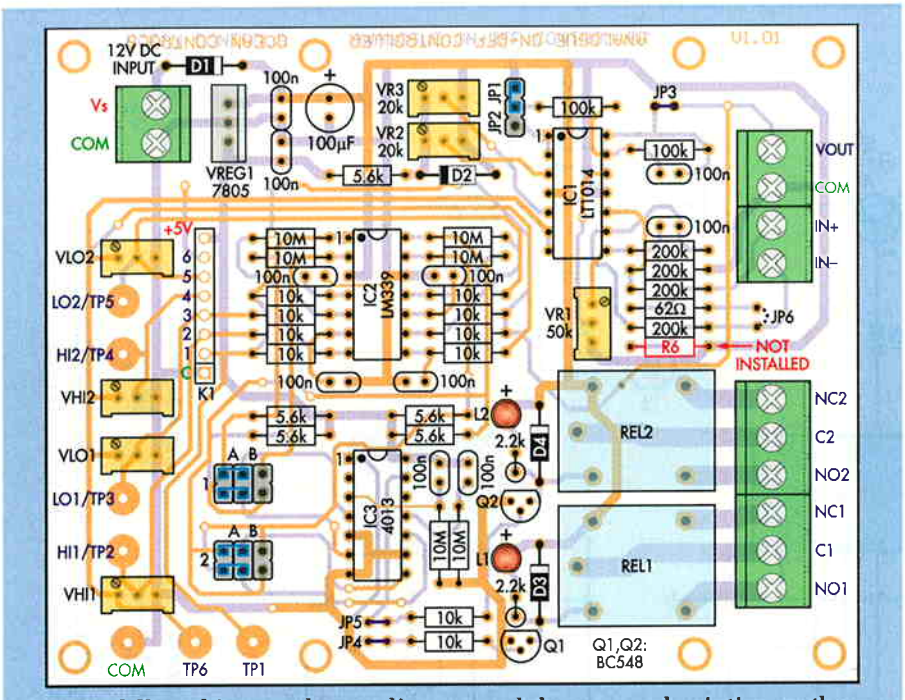
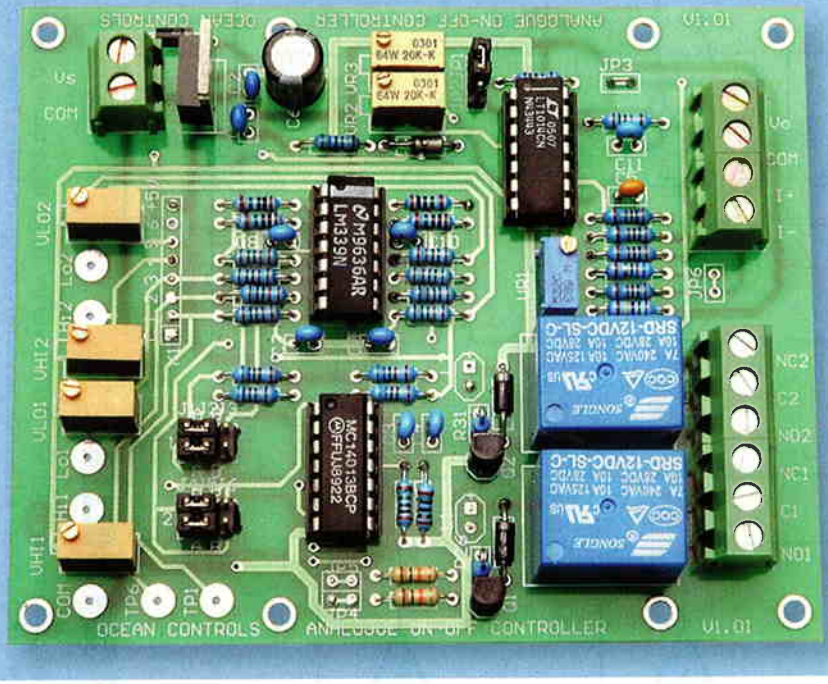


Fig.2: follow this parts layout diagram and the screened printing on the PC board during assembly. Leave out the two LEDs (L1 & L2) and links JP4 & JP5 if you've purchased the optional display panel!



is connected as a differential amplifier with unity gain, as determined by the four 200kΩ resistors used in its input and feedback networks.

Jumper JP6 is installed when the controller is used with a current loop type sensor, thus allowing current to flow through the 62Ω resistor and generate a voltage between the differential inputs.

The output from IC1c is fed into a second op amp (IC1d), also configured as a differential amplifier. In this case, a 50kΩ trimpot (VR1) takes the place of two resistors in the amplifier's input network, allowing it to be trimmed for a gain of 0-2.

This is used to scale the input signal to 1V full-scale ahead of the comparator network.

For example, when operating with a 0-20mA input range, the gain would be adjusted to produce 1V at the op amp's output with 20mA of loop current. For a 0-5V input range, the gain would be adjusted to produce 1V out with 5V in.

For a 4-20mA input range, the gain would be adjusted to produce 1.25V with 20mA in. An offset of 0.25V (adjustable with VR2) can be applied to the inverting input via JP2 to subtract from the signal on the non-inverting input, thus producing 0-1V (representing 0-100% of scale) at the output.

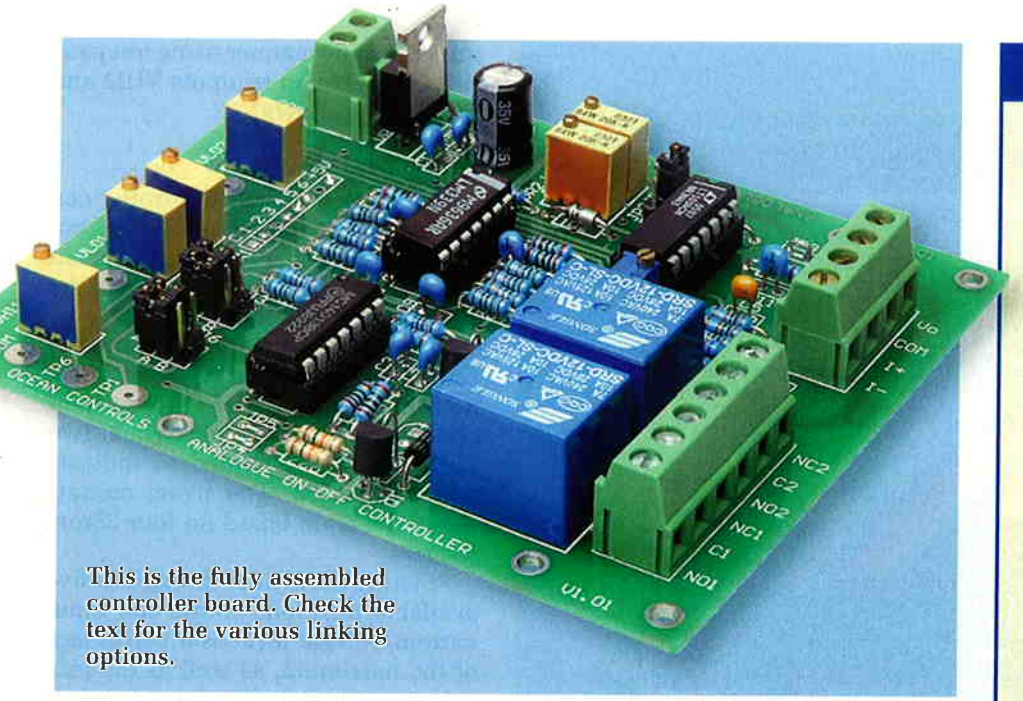
A simple shunt regulator comprised of a 3.3V zener diode (D2) and 5.6kΩ resistor forms a stable reference for the circuit. The regulator's output feeds two 20kΩ trimpots (VR2 & VR3), with their wiper voltages buffered by two unity-gain op amps (IC1a & IC1b).

VR3 is trimmed for 1V at the output of IC1b (pin 7). Further, the reference voltage for each comparator can be adjusted within the 0-1V range using trimpots VLO1, VHI1, VLO2 & VHI2.

The outputs of comparators IC2b and IC2c will go high (near +5V) when the voltage at their non-inverting in-

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	6	10MΩ	brown black blue brown	brown black black green brown
❑	4	200kΩ	red black yellow brown	red black black orange brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	10	10kΩ	brown black orange brown	brown black black red brown
❑	5	5.6kΩ	green blue red brown	green blue black brown brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	1	62Ω	blue red black brown	blue red black gold brown



This is the fully assembled controller board. Check the text for the various linking options.

puts is greater than that of the reference level on their inverting inputs. Conversely, the outputs of IC2a and IC2d will go high when the voltage at their inverting inputs is less than that of the reference level on their non-inverting inputs.

A high value (10MΩ) resistor is used to feed a small amount of each comparator's output signal back to its input, eliminating oscillations near the switching point.

Each comparator pair drives the "set" and "reset" inputs of a D type flipflop (IC3a & IC3b). A high from the comparator connected to the set input will cause the Q output to latch high, biasing its associated transistor into conduction and energising the relay. Conversely, a high on the reset input causes the Q output to go low, switching off the relay.

As shown, the outputs of each comparator pair can be steered to either flipflop input, depending on the position of the A and B jumpers. This allows each output to be switched on or off on a rising or falling input signal level.

Finally, the flipflops' clock inputs are connected to simple RC networks so that a short positive-going pulse is applied at power up. As the D inputs are grounded, this ensures that the Q outputs are reset (low) at startup and that both relays are initially off.

Calibration and setup

Before use, the controller must be calibrated to suit the intended application. All you need is a digital multimeter and a voltage (or current) source set to the maximum input signal level.

To begin, connect a 12V DC power supply to the Vs and COM inputs. Remember to disconnect power when making jumper or link changes.

For 4-20mA operation:

- Install a link at JP6.
- Install a jumper in the JP1 position.
- Supply 20mA to the inputs (IN+ & IN-).
- Adjust VR1 to give 1.25V at TP1.
- Move the jumper at JP1 to position JP2.
- Adjust VR2 to give 1.00V at TP1.
- Adjust VR3 to give 1.00V at TP6.

For 0-20mA operation:

- Install a link at JP6.
- Install a jumper in the JP1 position.
- Supply 20mA to the inputs (IN+ & IN-).
- Adjust VR1 to give 1.00V at TP1.
- Adjust VR3 to give 1.00V at TP6.

For 0-5V (or 0-10V) operation:

- Remove link at JP6.
- Install a jumper in the JP1 position.
- Supply 5.00V (or 10.00V for 0-10V operation) to the inputs (IN+ & IN-).
- Adjust VR1 to give 1.00V at TP1.
- Adjust VR3 to give 1.00V at TP6.

Parts List

1 double-sided PC board, 87 x 107mm
2 3-way 5.08mm 10A terminal blocks
3 2-way 5.08mm 10A terminal blocks
2 7A/240VAC relays with 12V DC coils
1 12-way 2.54mm DIL header strip (break in half for 2 x 6-way strips)
1 3-way 2.54mm SIL header strip (JP1/JP2)
5 jumper shunts
3 14-pin IC sockets
1 50kΩ 10-turn trimpot (VR1)
2 20kΩ 10-turn trimpots (VR2, VR3)
4 2kΩ trimpots (VHI1, VLO1, VHI2, VLO2)

Semiconductors

1 7805 +5V regulator (VREG1)
1 LT1014 quad precision op amp (IC1)
1 LM339 quad comparator (IC2)
1 4013 dual flipflop (IC3)
3 1N4004 silicon diodes (D1,D3, D4)
1 1N4728 3.3V zener diode (D2)
2 BC548 transistors (Q1, Q2)
2 3mm red LEDs (L1, L2)

Capacitors

1 100µF 35V electrolytic
10 100nF 50V monolithic ceramic

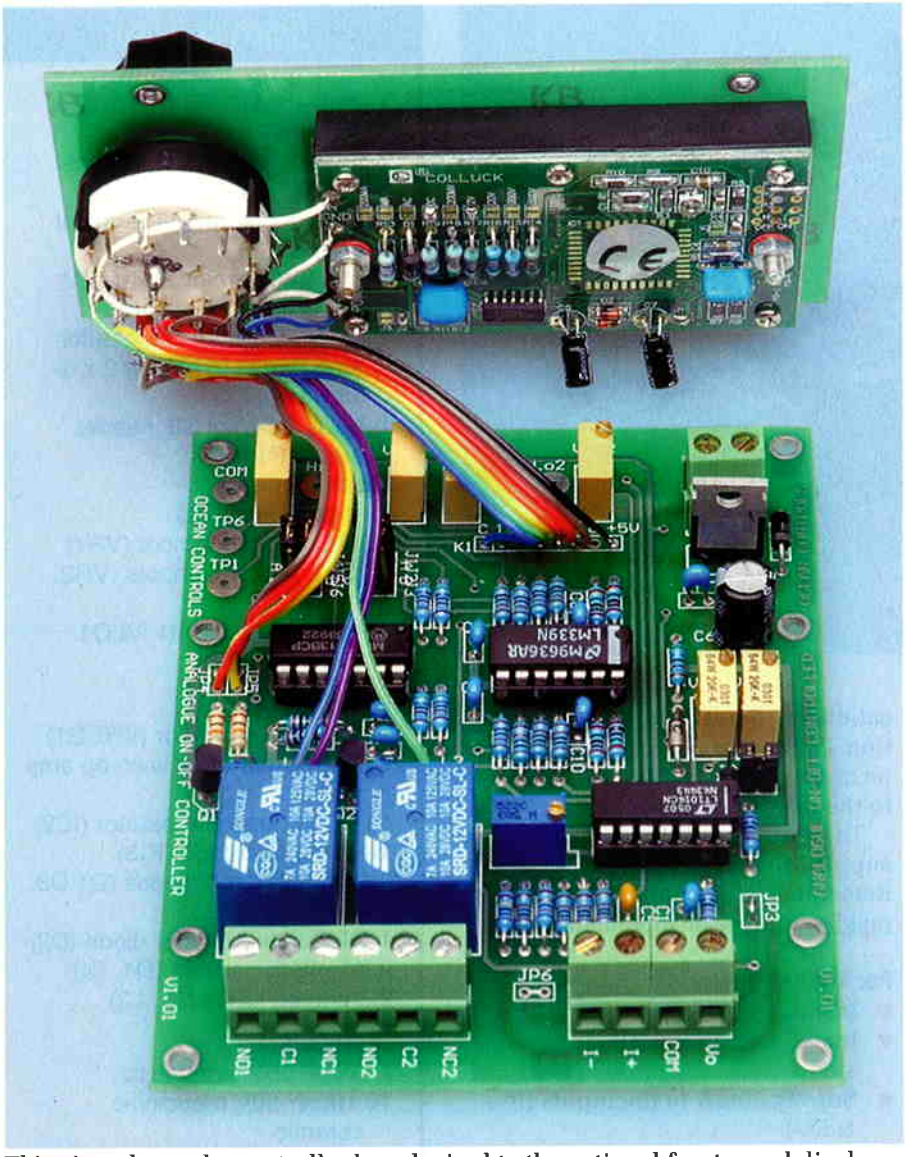
Resistors (0.25W, 1%)

6 10MΩ
4 200kΩ
2 100kΩ
10 10kΩ
5 5.6kΩ
2 2.2kΩ
1 62Ω

Parts For Optional Display Panel

1 PC board, 57 x 107mm
1 PM128E LCD panel meter
1 DPDT mini toggle switch
1 single pole 12-way rotary switch
1 knob to suit above
4 6mm M3 screws
4 20mm M3 screws
4 10mm M3 tapped spacers
4 25mm M3 tapped spacers
150mm length of 16-way ribbon cable

Once calibration is complete, each relay can be set to operate on either a rising (jumper in position in "A")



This view shows the controller board wired to the optional front-panel display board. The display board carries an LCD panel meter which makes it easy to adjust the on/off trip levels without using a multimeter (see Fig.3 for the wiring details).

or falling (jumper in position "B") input signal. The rising and falling trigger levels can then be set for both outputs.

To set the rising (high) level for the first relay output, measure the voltage at the test pad labelled "HI1" and adjust it using trimpot VHI1. A reading of 0.8V will mean that the relay switches on at 80% of the maximum input signal, while 0.6V equates to 60%, etc.

To set the falling (low) level for the first relay output, measure the voltage at the test pad labelled "LO1" and adjust it using trimpot VLO1. A reading of 0.2V will mean that the relay switches off at 20%, while 0.3V equates to 30%, etc.

The other output is adjusted in exactly the same manner using test pads HI2 and LO2 and trimpots VHI2 and VLO2, respectively.

Front panel add-on

The Analog On-Off Controller can be ordered with an optional LCD front panel, allowing convenient adjustment and monitoring of the unit without the use of a multimeter.

The front panel consists of an LCD panel meter mounted on a small section of PC board alongside a 5-position rotary switch and a toggle switch. Two LEDs are also provided to indicate relay activation. The panel mounts above the main board on four 35mm spacers.

Rotating the switch through its five available positions shows the input current/voltage level as a percentage of the maximum, as well as the programmed on and off points of each of the relays.

Setting of the four switching levels is easily performed with the front panel meter. Simply rotate the switch through positions Hi1, Lo1, Hi2 and Lo2 and adjust trimpots VHI1, VLO1, VHI2 and VLO2 as described earlier.

Note that VR1, VR2 and VR3 are set during initial calibration and must not be altered here.

The "duty" switch on the front panel swaps the on and off levels of Relay 1 with those of Relay 2. This is useful when a "duty" and "standby" setup is required, allowing the operation of two devices to be periodically swapped to ensure even wear.

Example application

The Analog On-Off Controller has a large range of potential applications. Let's look at a couple that involve water pumping.

For example, suppose two pumps are to be used to fill a water tank. The "duty" pump (connected to relay 1) could be set to start when the level drops below 40% and stop when it rises above 65%, whereas the "standby" pump (connected to relay 2) could start at 35% and stop at 70%.

Table 1: Application Examples

Operation	Relay 1	Relay 2	Jumper Block 1	Jumper Block 2	Hi1	Lo1	Hi2	Lo2
Two pumps filling a tank	Duty pump	Standby pump	A (falling)	B (falling)	65.0	40.0	70.0	35.0
Two pumps emptying a tank	Duty pump	Standby pump	B (rising)	A (rising)	60.0	50.0	70.0	55.0

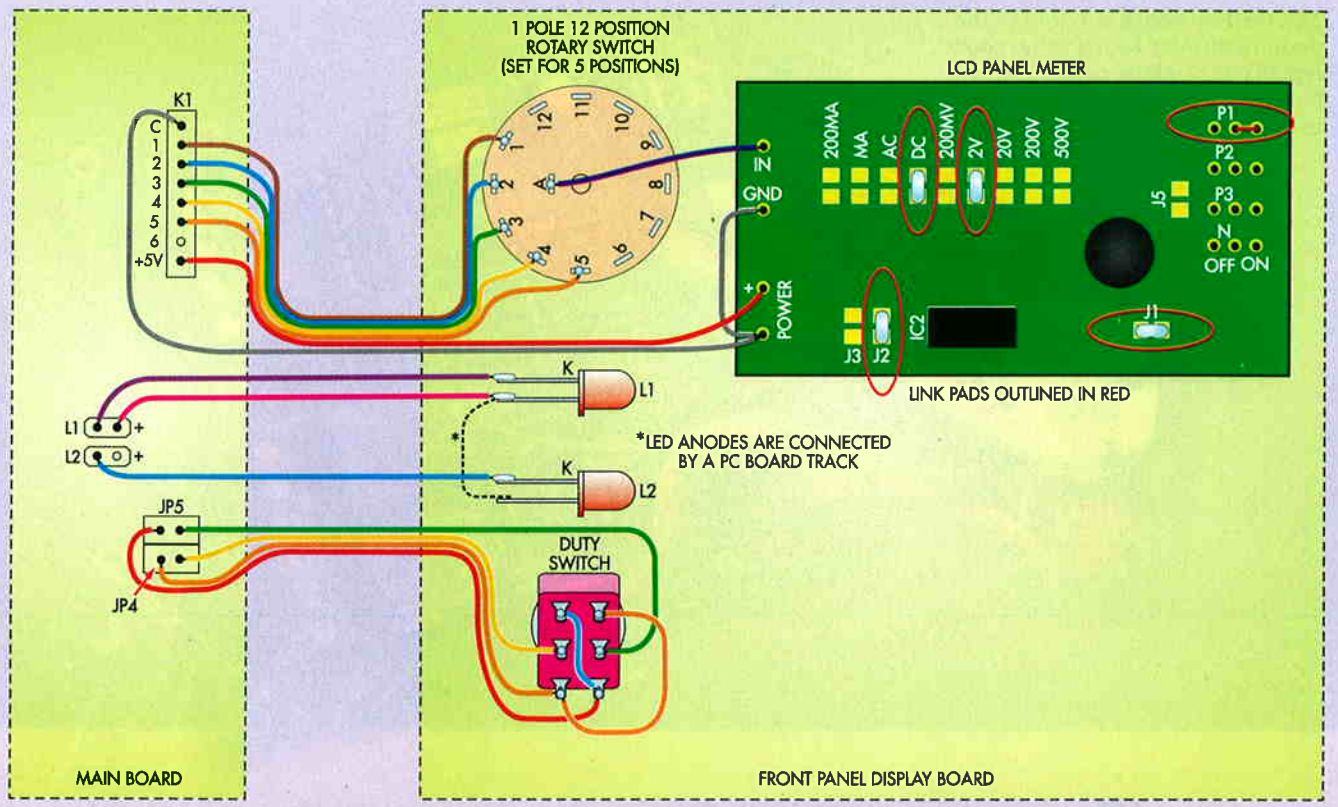


Fig.3: here's how to wire the display board to the controller. Leave enough wire length to allow the two boards to be stacked together later. Note that several links (circled in red) must be placed on the LCD panel meter before use. In four places, the pads can simply be shorted with blobs of solder. For the "P1" position, a short length of wire will be required instead.

A similar example can be given for emptying a tank. Suppose that the "duty" pump starts at a level of 60% and stops when the level falls below 50%, whereas the "standby" pump starts when the level reaches 70% and stops when it falls below 55%. Table 1 shows the settings required for these two examples.

Extended operation

In some applications, more than two devices must be controlled from a single input signal. For example, you may have a duty pump switching on at 80% and two standby pumps switching on at 85% and 90%.

This is easily accommodated by installing a second controller and making a few minor changes. First, connect the "V_{OUT}" terminals of the two controllers together. The input signal is then connected to the first controller only, while link JP3 is removed from the second controller.

Assembly

Before starting construction, note that the two LEDs and links JP4 & JP5 must not be installed if you will be fitting the optional display panel.

Using the overlay diagram in Fig.2 as your guide, begin by installing wire links in place of jumpers JP3-JP6, noting that JP3 is only fitted when using a current loop input. Next, install 3-way header pins for jumpers JP1 & JP2 and 6-way headers for jumper blocks "1" and "2".

The resistors, capacitors, diodes (D1-D4) and transistors (Q1 & Q2) can all go in next. Note that resistor R6 (shown in red in Fig.2) is not required – just leave this location empty.

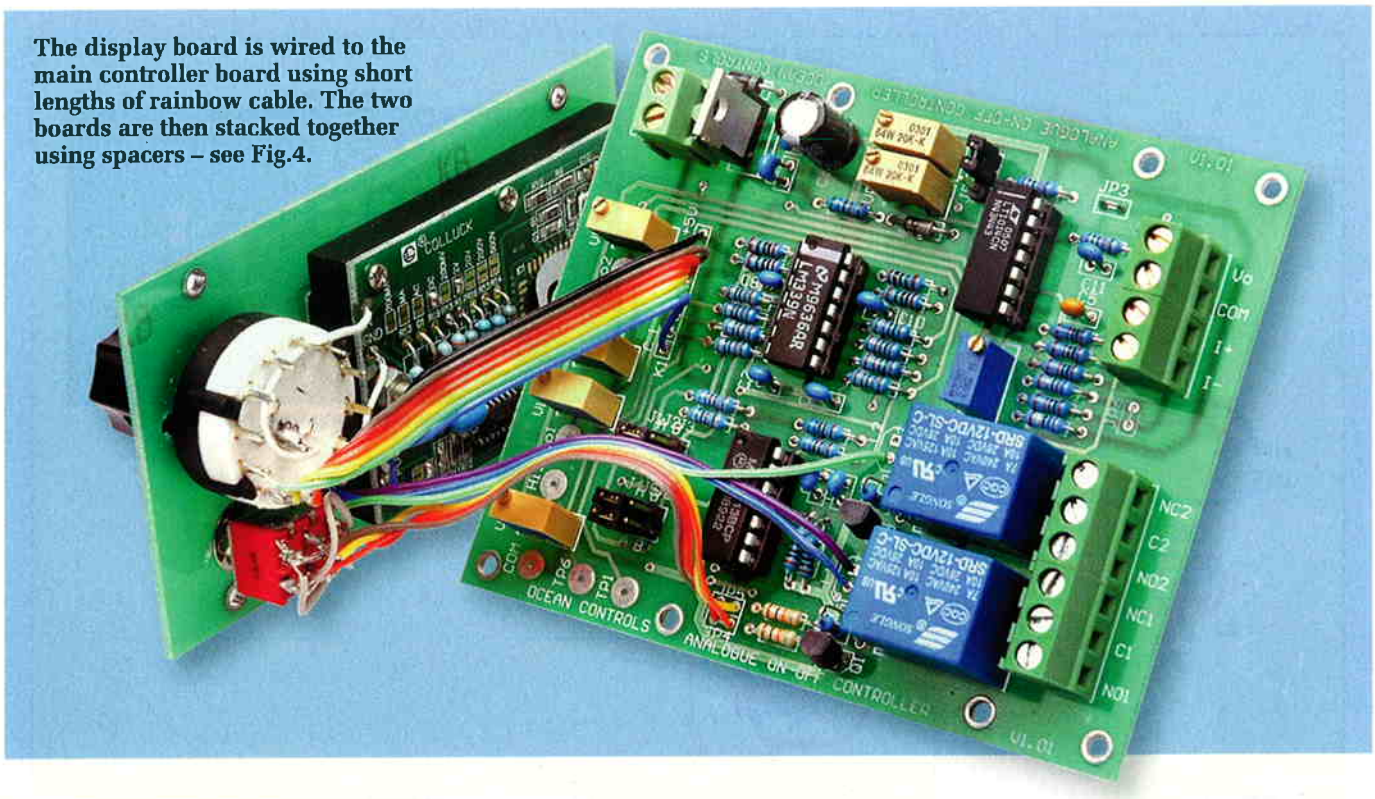
Take care with the orientation of the 100µF electrolytic capacitor – be sure to align its positive lead with the "+" marking on the overlay. In addition, the banded (cathode) ends of the diodes and the flat sides of the transistors must be oriented as shown.

After this, solder in the trimpots (VR1-VR3, VLO1, VHI1, VLO2 & VHI2), LEDs (L1 & L2), voltage regulator (VREG1) and IC sockets. Again, take care to ensure that all these parts are correctly orientated. Don't plug in

Suggested Uses For The Controller

The Analog On-Off Controller could be used to:

- Operate one or two pumps based on the level in a tank or well.
- Operate pumps in a duty-standby arrangement.
- Regulate pressure using a compressor and a pressure sensor.
- Control a heating or cooling appliance using a temperature sensor.
- Regulate humidity using exhaust fans and a humidity sensor.
- Control chemical dosing, given an appropriate sensor.
- Almost anywhere that an analog signal level can be used to turn a device on and off.



The display board is wired to the main controller board using short lengths of rainbow cable. The two boards are then stacked together using spacers – see Fig.4.

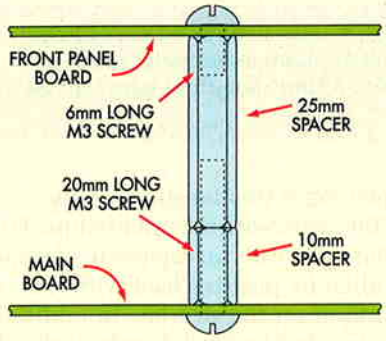


Fig.4: the display panel board is mounted above the main board on four 35mm tapped spacers, in turn assembled from shorter 25mm and 10mm items. Here's how it goes together.

the ICs until after you've checked the power supply.

All that remains now are the terminal blocks and relays; install these now and perform a final check of your board before applying power.

Now connect a 12 DC source to the Vs and COM terminals and measure the voltage at the output of the regulator, accessible at pins 7 & 14 of IC3's socket. Obviously, the supply rail should measure 5V (±5%). If all is well, power off and insert the IC's in their sockets, noting that the notched (pin 1) ends must be oriented as shown.

Display panel

The optional display panel is assembled next. The PC board provides pads for just two 3mm red LEDs – so install these first. The anode side of the LEDs (indicated by the longer lead) goes into the holes marked with a "+" on the silkscreen. Leave about 5-10mm of length when trimming the leads, so that wires can be attached later.

Once the LEDs are in place, mount the LCD panel meter, rotary switch and toggle switch. Note that the rotary switch must be programmed for 5-position operation before mounting. This is easily achieved by inserting the tab of the ring in hole "5", so that the switch can only be rotated through the first five positions.

Before use, five links must be installed on the LCD panel's PC board, as shown in Fig.3. Short links J1, J2, DC and 2V with blobs of solder. A wire link will be required to connect "P1" to the "ON" side.

Short lengths of ribbon cable can now be used to connect the two boards together, as depicted in Fig.3. That done, mount the display assembly above the main board using tapped spacers and screws as shown in Fig.4.

Your Analog On-Off Controller is now ready for use. Remember, if you are going to use it to switch 240VAC mains voltages, the wiring must be installed by a licensed electrician. **SC**

Where To Buy A Kit Of Parts

The Analog On Off Controller was developed by Ocean Controls, who retain the design copyright. The controller is available as a kit of parts or preassembled and tested. Prices at time of publication were:

Analog On-Off Controller kit: $59 +GST ($70 +GST assembled).

Analog On-Off Controller kit and Display Panel kit: $84 +GST ($99 assembled, $119 with IP65 box).

PM-128E Panel Meter (included with the Display Panel option): $20 + GST.

Note that these prices do not include postage charges. Check out the Ocean Controls website at **www.oceancontrols.com.au** for more information or phone (03) 5983 1163 to order.

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SERVICEMAN'S LOG

Looks like a duck, quacks like a duck . . .

There's an old saying that if it looks like a duck, quacks like a duck and has feathers like a duck, then you've probably got a duck. If only faults in TV sets were so easy to recognise, although I did recently track down a fault by lightly feathering it with my paintbrush!

A Mitsubishi CT-2900AM TV set was fortunately brought into the workshop with a ticklish problem. I say fortunately because I am sure I would not have been able to solve this problem in the customer's home.

The problem was intermittent no horizontal or vertical synchronisation. Worse still, it was so random that it was hard to make it happen to order.

Usually, a set as old as this will be starting to become unreliable, with leaky electrolytic capacitors and dry joints. However, this set was pretty good on both counts – its owner had been sparing with the whip.

A glance at the circuit shows that the composite video leaves the AV switching IC (IC251) and goes through Q204 and Q605 to Q207 and then on to pin 33 of the jungle IC (IC201, LA7680). I connected an oscilloscope to pin 33 and eventually caught the lack of signal arriving there.

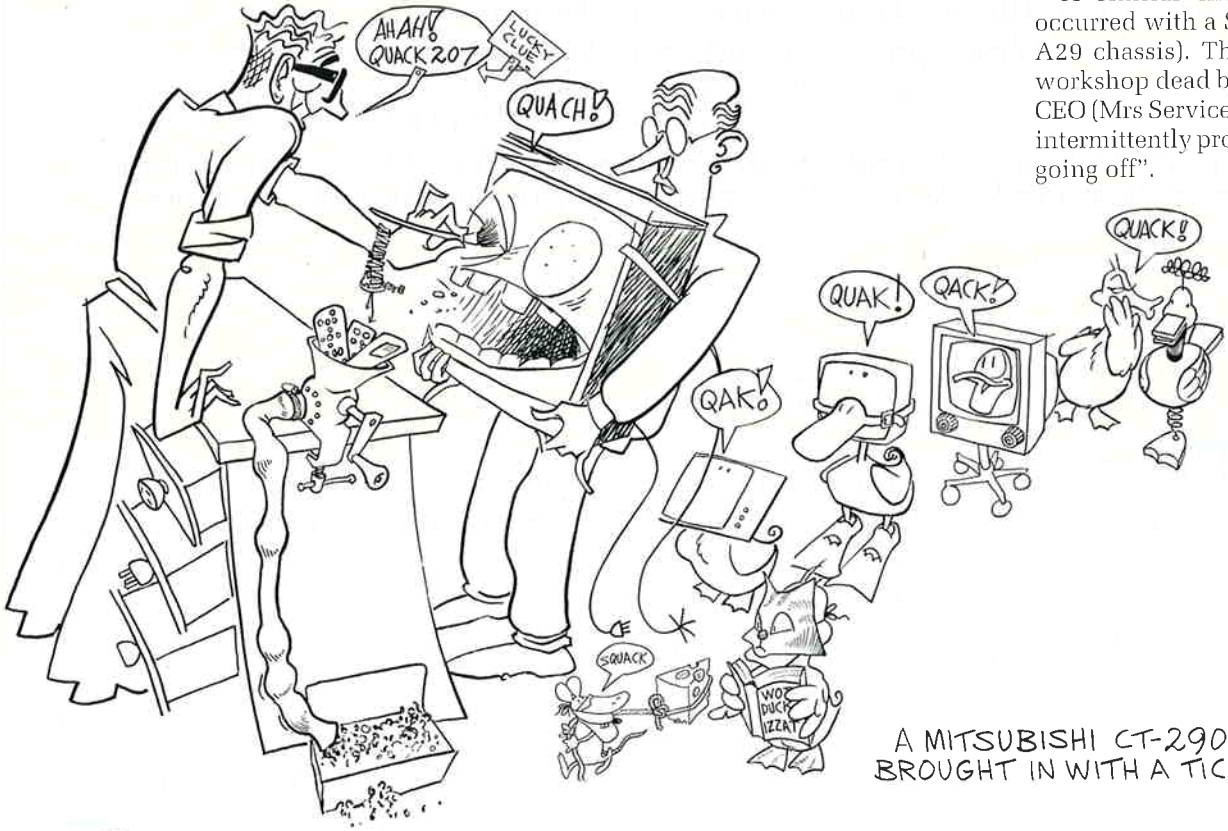
At this stage, I really felt it would be a piece of cake tracking this down with the weapons I had at hand – namely Mr Heater and Mrs Freezer, plus the arbitrator CRO. The problem was that heating and freezing didn't produce any effect that was measurable and tapping the board gave me no clues either.

In the end, I used a small paintbrush which I gently feathered over the components between the two ICs. My reasoning was that the soft bristles might affect the circuit and give me a clue and I was in luck. Gradually, this lead me to coil L211 on the base of the video amplifier transistor Q207. I couldn't fault it visually but it turned out to be dry-jointed to the solder that covered its leads. Resoldering it fixed the problem.

My overall experience with this set is that it has been exceptionally reliable and is a good performer. The only other fault I have had with it that is worth mentioning is a "no-sound" symptom, caused by a leaky diode (D722) to microprocessor IC701 which affected the muting circuits.

Intermittent Sanyo

A similar intermittent problem occurred with a Sanyo CPP2930 (A8-A29 chassis). The set arrived in the workshop dead but the client told our CEO (Mrs Serviceman) that the set was intermittently producing "a line before going off".



A MITSUBISHI CT-2900AM TV WAS BROUGHT IN WITH A TICKLISH PROBLEM

Unfortunately, the critical part of this otherwise excellent description was not given: was the line vertical or horizontal? I was unable to find out because our client had promptly gone on holiday and was unavailable for two weeks.

It didn't take too long to work out that the line output transistor (Q403, 2SD1879) was short circuit. I didn't have one so I stuck in a BU508DF which did the trick. I also noticed several dry joints around the horizontal drive transformer and resoldered them.

Feeling pretty sure that I had correctly diagnosed and solved the problem, I put the set on the soak test trolley and moved on. But then, a couple of days later, just as it was getting towards "beer-o'clock", I looked at the set and noticed it was pulsating on and off.

My first impulse was to hit it but bashing the set made no difference, except that it made me feel better. I then removed the back and switched it on, whereupon the set promptly refused to fail again. I then tried heating and freezing it, especially around the new line output transistor, but it made no difference. I even covered the whole set with a blanket in an attempt to overheat it and it still worked.

OK, so it was going to play dirty. I put the back on properly and a few hours later it failed again. Ah-hah – a faulty cabinet back! I just knew it! The question was, was it short circuit or open circuit?

Infuriated by now that I was unable to get even close to what the problem was, I decided to pull the chassis out and completely dismantle it. It turned out to be a good decision. With the chassis under a "maggie" lamp, I found a number of very fine dry joints around the vertical output IC (IC501) and also around some of the interconnecting plugs and sockets on the board.

Resoldering these fixed the problem but why couldn't I detect it earlier? My theory is that with the chassis firmly back in the cabinet, these dry joints were exacerbated by the tension of the tight fit. When the back was released, the tension was released and the connections improved.

Well, it sounds plausible, so I'm sticking with it.

The swing to plasma & LCD

Sometimes, I am grateful that more work is swinging towards repairing plasma and LCD sets which are not nearly as heavy or bulky as their CRT equivalents. My main whinge about the newer technology is the number of screws that hold the backs on the sets and the sheer monotony of board replacement. This is rather frustrating because many of them could be repaired to component level but manufacturer policy is strictly board level.

Items Covered This Month

- Mitsubishi CT-2900AM TV set
- Sanyo CPP2930 TV set (A8-A29 chassis)
- Panasonic TC-32LX500A LCD TV set (LH41 chassis)
- Sony KV-EH36M31 FD Trinitron TV set (AE5A chassis)
- LG DC593W combo VCR + DVD
- Toshiba 56WHO8G rear projection TV
- LG RT28FZ10RX TV set (MC-022A chassis)

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other way round (which is much more usual).

Unfortunately, I never quite got round to identifying the exact components, though I suspect the flow soldering to either the surface-mounted 180-pin IC801 or 80-pin IC302 (which is beyond my ability to resolder) may have been the problem. Instead, an exchange B3 board, part number A1620124R, fixed the problem.

As Clint Eastwood put it: "A man's got to know his limitations".

Fixing the odd VCR

Most VCRs aren't worth repairing these days and even "combos" (VCR plus DVD) are at best borderline. Occasionally, however, I still fix the odd one or two.

One that I had in recently was a popular LG DC593W combo unit that had died during a power surge. Fuse F101 was open and after replacing it, you could hear a faint pulsating noise and the two front red LEDs were flashing.

I checked the seven main supply rails with an ohmmeter but couldn't find any short circuits. However, there were only very low pulsating voltages on them when the unit was switched on.

The main problem with these units is access or rather, the lack of it. To get to the main board where the power supply is, you have to remove the front panels and the VCR deck and board. It is almost impossible to run the set outside its cabinet.

It was fairly obvious that the power supply was oscillating, so I started by replacing C107 (1µF 50V) and C108 (33µF 25V). I also mounted IC101 in an IC socket so that I could swap it later if necessary without removing the chassis.

This restored the power to the set but I wasn't out of the woods yet. The display came on and the DVD did a few turns, as did the VCR, but a few bizarre symptoms remained.

First, all the segments of the display were glowing at once. Second, although the remote was working, when I switched it from DVD to VCR, the LEDs changed but the AV output remained in the DVD position. However, if I tuned the TV into the RF output (Ch68), I could choose between the DVD, the VCR and the TV stations but there was excessive RF interference patterning.

This red herring disappeared when I removed the aerial, which told me that I was getting co-channel interference from Ch66 or another digital channel. As a result, I chose a lower channel number for the RF output (press Ch Up and Down together for four seconds with the VCR off).

Next, I checked all the voltage rails and these proved to a bit high compared to the values marked on the circuit. As a result, I spent a lot of time changing IC101 (the "Power Management" IC), the optocoupler and IC102 (KA431) in an attempt to fix this. In the end, it turned out to be the main filter electro (C103, 100µF 400V). This was slightly low in capacitance and changing it fixed the DVD/VCR switching on the AV output.

But that wasn't the end of it – I still had the Digitron fluorescent display (IC501) glowing too brightly. The filaments seemed OK at 4V and the -29V rail measured -30V at the anode of D108. However, when I checked the voltage on pin 11 of the P6M01 plug and socket for the front panel, it was very low at about -17V and varying.

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With the board out, I soon tracked the fault down to capacitor C122 which had come loose and broken a very fine copper track. Repairing this fault fixed the Digitron display but I wasn't out of the woods yet.

The last fault was intermittent "no eject" from the DVD. This was caused by a slipping loading motor belt and replacing it fixed that problem. You can see why, generally speaking, these combos are not worth fixing, especially when new units can be had for less than $200.

One of the traps one can get into with this unit is the front control panel not working due to inadvertent use of the child lock on the remote control.

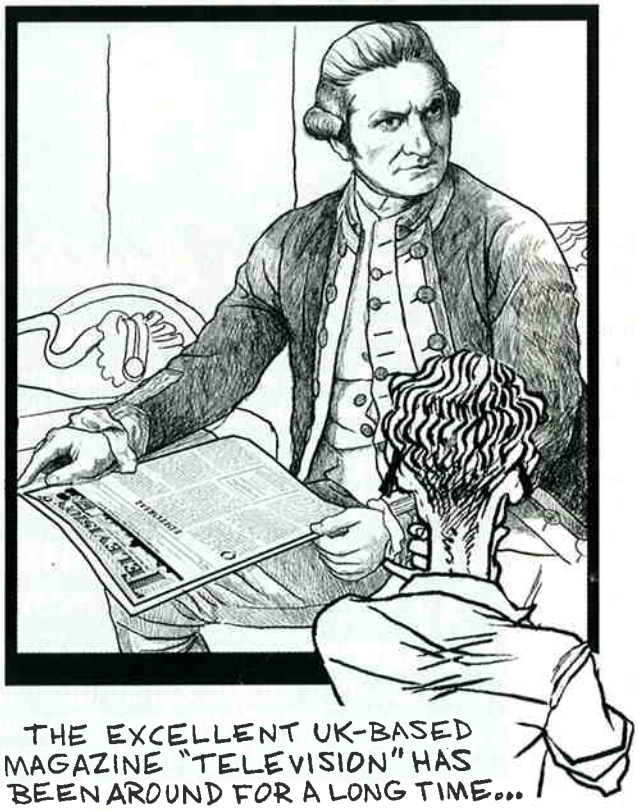
Rear projection set

We had a Toshiba 56WHO8G rear projection TV come in marked "dead" on the job sheet. I hate rear projection TVs at the best of times because of their logistics and lack of access.

We found that the set would come on OK for a few seconds but then close down completely. All the voltages checked OK except for one and that was the X-ray protect voltage on pin 13 of Z801, a special thick-film power management IC. The circuit shows this to be 22V but I measured just 3V.

The circuit shows that this voltage is derived from pin 9 of the flyback transformer (T461) via D471, R471 and C471. These parts were all changed but that made no difference. We then disconnected this line by removing the GJ14 link and the set now stayed on but was showing a horrible concave picture.

This made us think that there could be some ghastly



fault on the convergence board. It was looking more and more like a complete disaster and we really didn't want to touch it, especially as the customer did not want to spend money on it.

In the end, he bought a new plasma TV and dumped the projection TV on us. As a result, the monster was put aside so that it could be salvaged for spare parts.

A few months later, another identical model also came in dead. This time, the fault was R820, a 1.8Ω fusible resistor that supplies +156.7V to IC801.

Well, now that we had this set working, we decided to swap its modules with our faulty unit to track the problem down. Surprisingly, the fault wasn't in the convergence or deflection circuits as we had thought. Instead it turned out to be the power supply.

We then began comparing the two identical power supply modules side by side on the bench and soon realised that their circuits were significantly different to the circuit supplied in the service manual – especially the X-ray protection circuitry. Anyway, swapping parts between the two boards eventually lead us to the power management IC itself – swapping it transferred the fault and a new one fixed the problem.

Does anyone know who wants to buy a secondhand Toshiba rear projection TV?

Bizarre fault

We recently encountered a really bizarre fault in a 3-year old LG RT28FZ10RX (MC022A chassis) TV set. It came in with "green and pink picture" written on the job sheet and, on the workshop bench, the colour bars looked as though they had been swapped over, or the wrong TV system selected.

This was all thoroughly checked out, after which the set was externally degaussed. Everything else, including the software settings, looked OK, the only exception being that the purity was slightly out.

This was rather puzzling. The set hadn't been dropped, the degaussing circuits were OK and no-one had had a fiddle. The ring magnets around the CRT were all sealed with the original manufacturer's white paint, so they hadn't been touched either.

With no other option available, the decision was made to redo the purity and convergence adjustments. And that did it – once these adjustments were completed, all the colours were correct!

So what had happened? If that's the way the set had left the factory (highly improbable), why did it take so long for someone to notice this problem? Was the client colour blind?

I can only surmise that the set had been dropped at some stage and no-one had owned up! It's the only explanation that makes sense.

Relics of a bygone era

The excellent UK-based magazine "Television" has been around for a long time (I have subscribed since 1963) but just recently the Poms have been running a series of self-congratulatory articles on the brilliance of their AVO 8 multimeters. However, in my opinion, there's no way you can compare the AVO 8s with a Spitfire for technical excellence.

Being an expat myself – and thus in danger of bringing on some heavy criticism – I have to say I don't share their enthusiasm. Even the latest series was big, heavy and only 20kΩ/V – and rather expensive.

I own two series 5 units which did not bounce when they hit the concrete floor in my workshop and my bank manager will not let me have the mortgage required to fix them. So they sit on a shelf, relics of a bygone era.

By now I am sure I have upset at least half of my dwindling readership but you can try to convince me otherwise. I will, however, continue to praise the performance of several other multimeters of the 70s and 80s – eg, Taylor, University, Sanwa and my favourite, Hioki-Peak. These were available in Aussie dollars for a fraction of the UK pounds you pay for an AVO and had an input impedance of 100,000Ω/V. They also used a 28V battery for ohms measurements, which meant that when you tested a transistor, it was as though it was in a fully working circuit and any leakage problems would stand out like a dog's proverbials.

Unfortunately, my favourite meters also didn't survive the bench drop and are no longer available except possibly in garage sales from retired or deceased electrical engineers. Anyway, if any of you want to sell me a cheap Japanese meter like the ones I have mentioned, please let me know – I might be interested. SC

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PRODUCT SHOWCASE

DSE's TENs unit kit looks like a pro . . .

Dick Smith Electronics have submitted their built-up version of the Pocket TENS kit for evaluation (described in SILICON CHIP in January 2006) – and we must say it looks every bit as good as the professional units on the market but of course is just a fraction of the price.

For those who might not have seen the issue and are wondering what TENS units do, they provide an electrical stimulation to nerves under the skin via a pair of self adhesive electrodes (as seen in the photo at left).

They're used extensively by physiotherapists and other health care professionals to relieve pain and stiffness and are said to have soothing properties for labour pain. They're battery operated so there is no danger of zapping yourself – but don't wind the wick up before turning the TENS unit on! You could be in for a painful experience . . .

The Dick Smith Electronics kit comes complete with the self-adhesive pad electrodes (often the hardest part to come by!) and is completely true to the SILICON CHIP design.

It sells in DSE stores or via the website for $69.96 (Cat K-3705).

Contact:
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Bioloid Robot kit from Tribotix

The Bioloid Robot kit is very popular amongst hobbyists and educators, with global acceptance in many universities and secondary schools as an excellent teaching aid. The Robot kit can be used to build a vast variety of robot forms. Some examples are the ever popular Humanoid, Walking Droid, Dog, Spider, Snake, Dinosaur or Excavator.

The Bioloid has many significant technological advances over other recently released robot kits. The motors are of the "Smart Actuator" kind, which can function as both a traditional servo positioning device and a full-rotation motor. They are fully networked to one another, each with their own onboard Micro. The power that an onboard micro provides is impressive with a large range of accessible parameter settings such as torque, speed, current position and target position.

A sensor module also comes with the kit providing an impressive array of sensory inputs. The network that binds the motors and sensors together is a simple daisy chain configuration with fixed connectors making wiring simple. All that is required for assembly is a Phillips screwdriver and a pair of long nose pliers.

The kit also comes with 3D motion software which enables the user to create complex motion sequences quickly and easily. The user just positions the robot, saves the pose and repeats this action until a complete motion sequence has been saved to onboard flash memory.

This motion sequence can then be called by the software, enabling complex sensory/motion interaction to be developed in literally minutes.

The control software itself can be written in "C", for the control module's Atmel processor or, for beginner programmers, a proprietary GUI-based language.

This is popular for secondary school users.

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As you can see from pages 102-104, we pay good money for each "Circuit Notebook" item published in SILICON CHIP. But there are four more reasons to send in your circuit idea.

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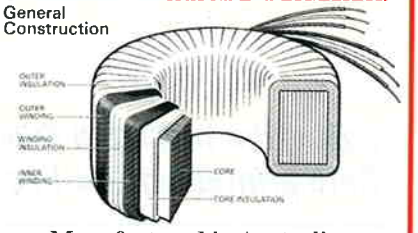

Manufactured in Australia
Comprehensive data available
Harbuch Electronics Pty Ltd
9/40 Leighton Pl. HORNSBY 2077
Ph (02) 9476-5854 Fax (02) 9476-3231

PC-based Vector Network Analyser

Omicron-Lab, represented in Australia by Emona Instruments, has introduced a unique and cost-effective PC-based Vector Network Analyser called the Bode 100.

It covers the frequency range 10Hz-40MHz and can be used as a gain phase meter, vector network analyser, impedance meter and sine wave generator.

Because of the wide frequency range it is suitable for AF, video and RF applications while its high accuracy and the pc-based control make it ideal for electronic labs as well as for production fields. The remarkably low price of the Bode 100 also makes it ideal for educational institutions, where Vector Network Analysers have usually been out of

reach due to their high price.

All test results can be imported to word processing software (eg, MS Word) which simplifies documentation, making data processing and sharing of results possible.

The applications of Bode 100 range from measuring complex transfer functions of amplifiers and filters to measuring the impedance and reflection in the Smith chart to Bode plots of control systems and more. The switchable receiver impedance (50Ω/ 1MΩ) gives you full flexibility in your measurement setups.

Contact:
Emona Instruments Pty Ltd
PO Box 15, Camperdown NSW 1450
Tel: (02) 9519 3933 **Fax:** (02) 9550 1378
Website: www.emona.com.au

New Jaycar store at Springvale, Vic.

More often than not the Jaycar Store in Springvale in Melbourne has been the Company's No.1 Store. But after 19 years the old store just got too small.

Jaycar has opened a new store right ***on*** the corner of Springvale Road & Dandenong Highway.

The phone number and opening hours have not changed but everything else has. It is twice the size of the old store and has customer parking right at the door.

Locals may recognise the building – it was one of Dickie's up until last year!

The store will be staffed by enthusiasts who understand the products they sell and can provide their customers with knowledgeable advice that few other retailers can give.

Products include home and car alarm systems, test equipment, video

surveillance, car audio, electrical and electronic tools, cable, accessories, kits, electronic gadgets and more.

Contact:
Jaycar Springvale
Cnr Springvale & Dandenong Rds, Springvale Vic 3170
Tel: (03) 9547 1022 **Fax:** (02) 9547 1046
Website: www.jaycar.com.au

Looking for waterproof connectors? Look at Altronics...

Altronic Distributors have recently been appointed distributor of LTW products in Australia. LTW are an ISO-certified specialist waterproof connector manufacturer, who have been producing connector solutions for mining, agricultural, industrial and marine use since 1993.

LTW connectors are available in IP66, 67 & 68 ratings for use in almost any environment.

Altronics have a selected LTW range in stock, including multipin circular DIN, D-Sub and RJ45 in both line and chassis types. More specialised LTW lines are available on an OEM basis.

Most chassis connectors have a matching screw or locking cap to ensure moisture and dust does not damage equipment when leads are not connected.

Contact:
Altronics Distributors
174 Rowe St, Perth WA 6000
Tel: (08) 9428 2199 **Fax:** (08) 9428 2198
Website: www.altronics.com.au

And the winner is...

The May monthly winner of one of these superb DSE 20MHz dual-channel 'scopes is

Mr F Wentzel of Perth, WA

Want to be a winner? Simply subscribe to Silicon Chip (or renew your subscription) and your name could be drawn!

See P47 of this issue for full details!

Tribotix

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The Bioloid Kit is the first robotic kit based around "smart serially controlled servos" that allows the user to build multiple types of robots.

Major components include:
- CM-5 mcu (Atmel ATMega128),
- 19 AX-12 serially controlled Servo's,
- 1 AX-S1 Sensor module,
- Rechargeable battery pack (9.6V),
- 2 Programming Utilities (**freeware**), and
- vast assortment of frames, nuts & bolts.

This kit is exceptional value and is ideally suited for hobbyists, schools & universities.

email: sales@tribotix.com
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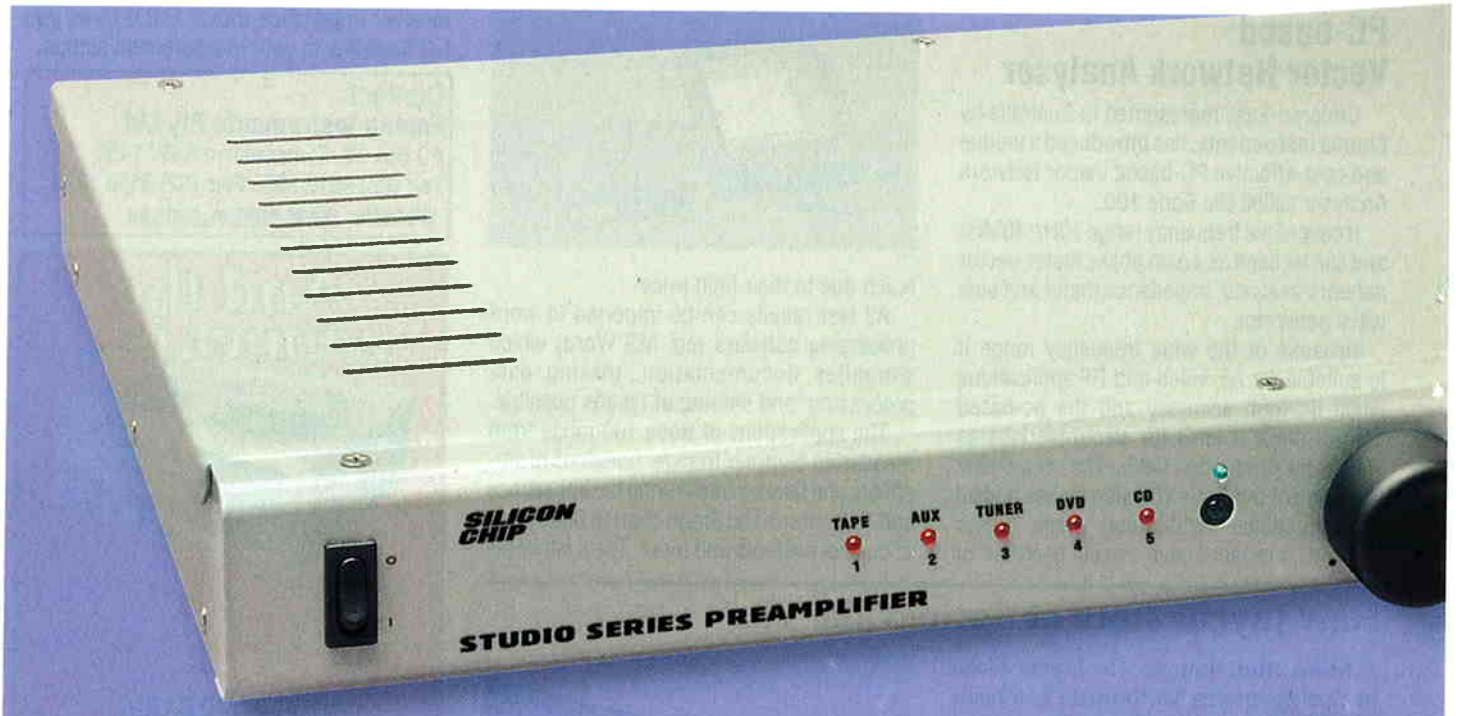
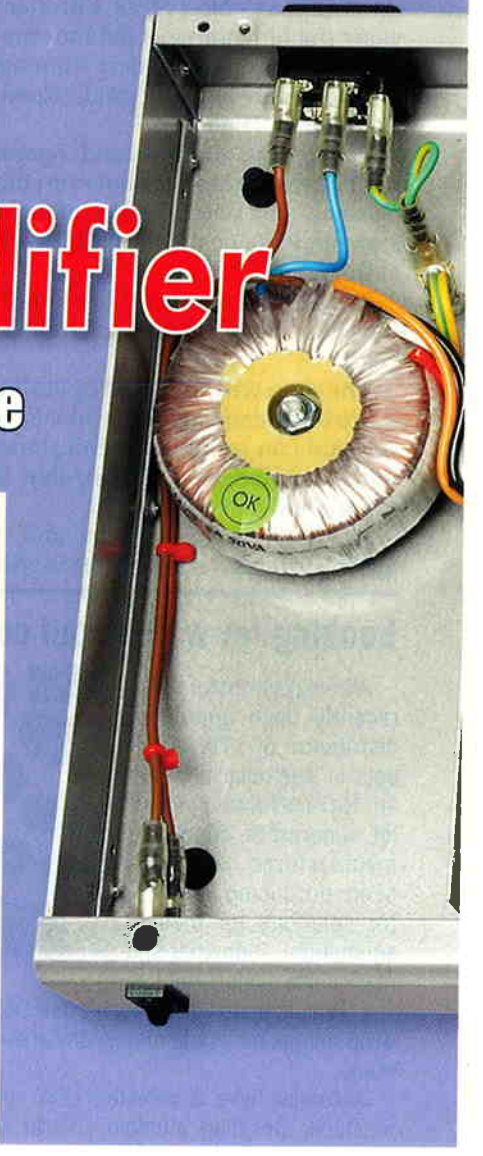


Studio Series Stereo Preamplifier

Installing The Modules In A Case

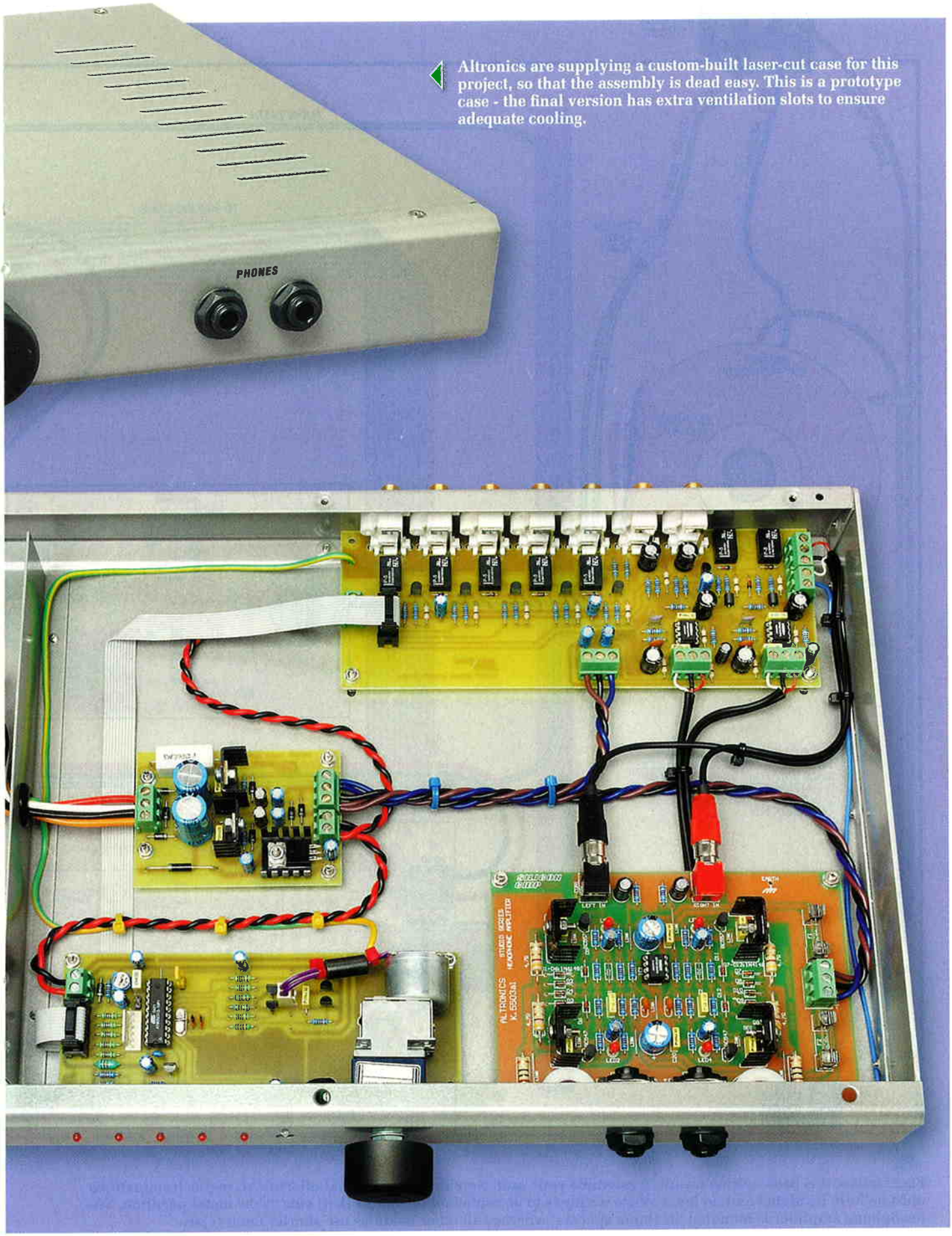


At last! – here's how to assemble your high-performance Studio Series preamplifier modules into a professional quality case!

By PETER SMITH

BACK IN THE OCTOBER 2005 issue, we described a stereo preamplifier module that sets new standards in low-cost, high-performance, build-it-yourself audio. The module boasts a minimalist design that typically produces less than .0005% total harmonic distortion and noise. Five relay-switched RCA inputs and a headphone output simplify wiring and minimise audio signal degradation.

A matching headphone amplifier followed in the November issue. This has already proven quite popular and is undoubtedly the cleanest and quietest we've ever described. Although designed for use with the preamp, the headphone amplifier also works as a standalone unit and can be connected directly to the line output of a CD or MP3 player. It has the ability to drive headphones down to 8Ω impedance with low distortion, while a second output socket allows connection of



Altronics are supplying a custom-built laser-cut case for this project, so that the assembly is dead easy. This is a prototype case - the final version has extra ventilation slots to ensure adequate cooling.

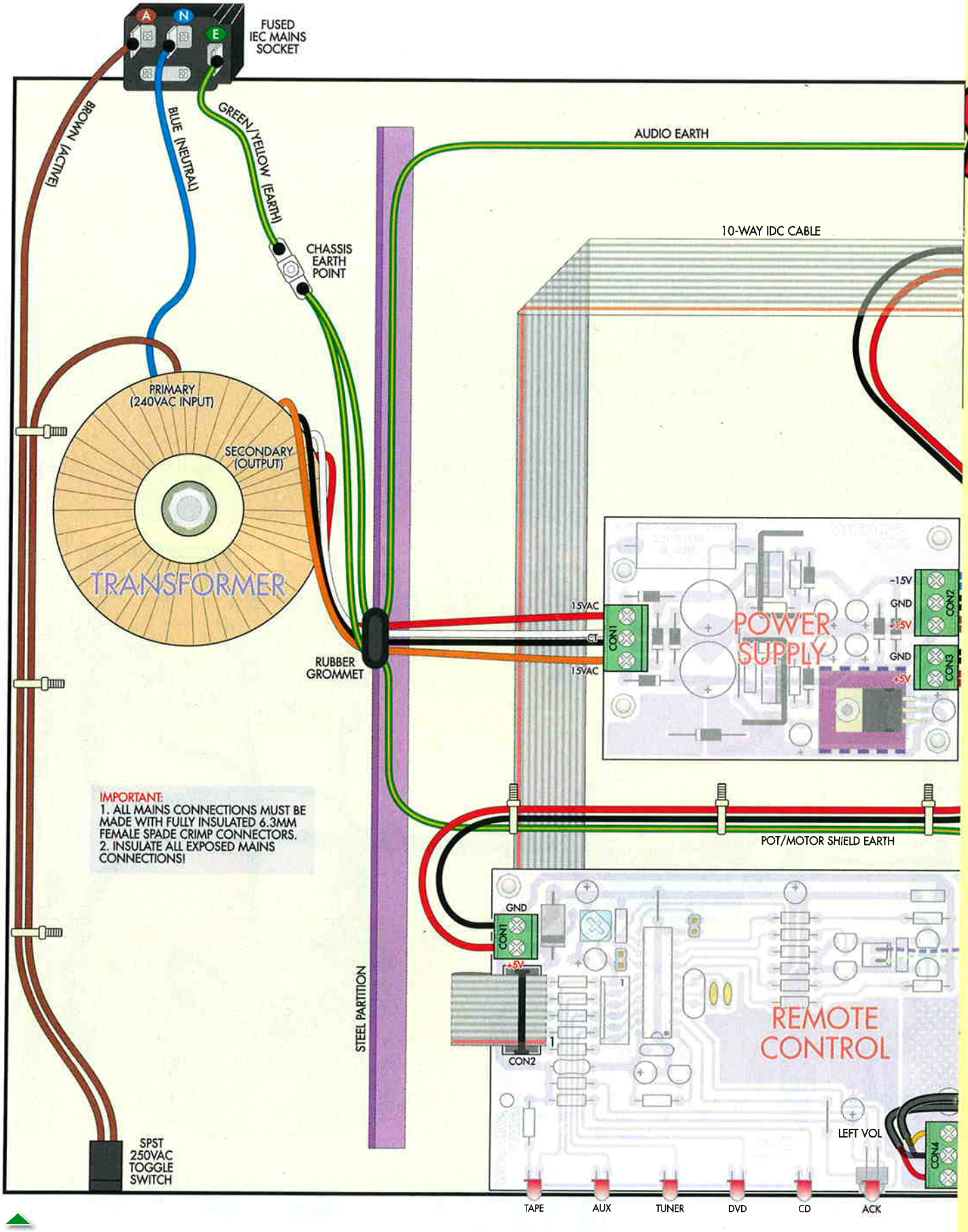
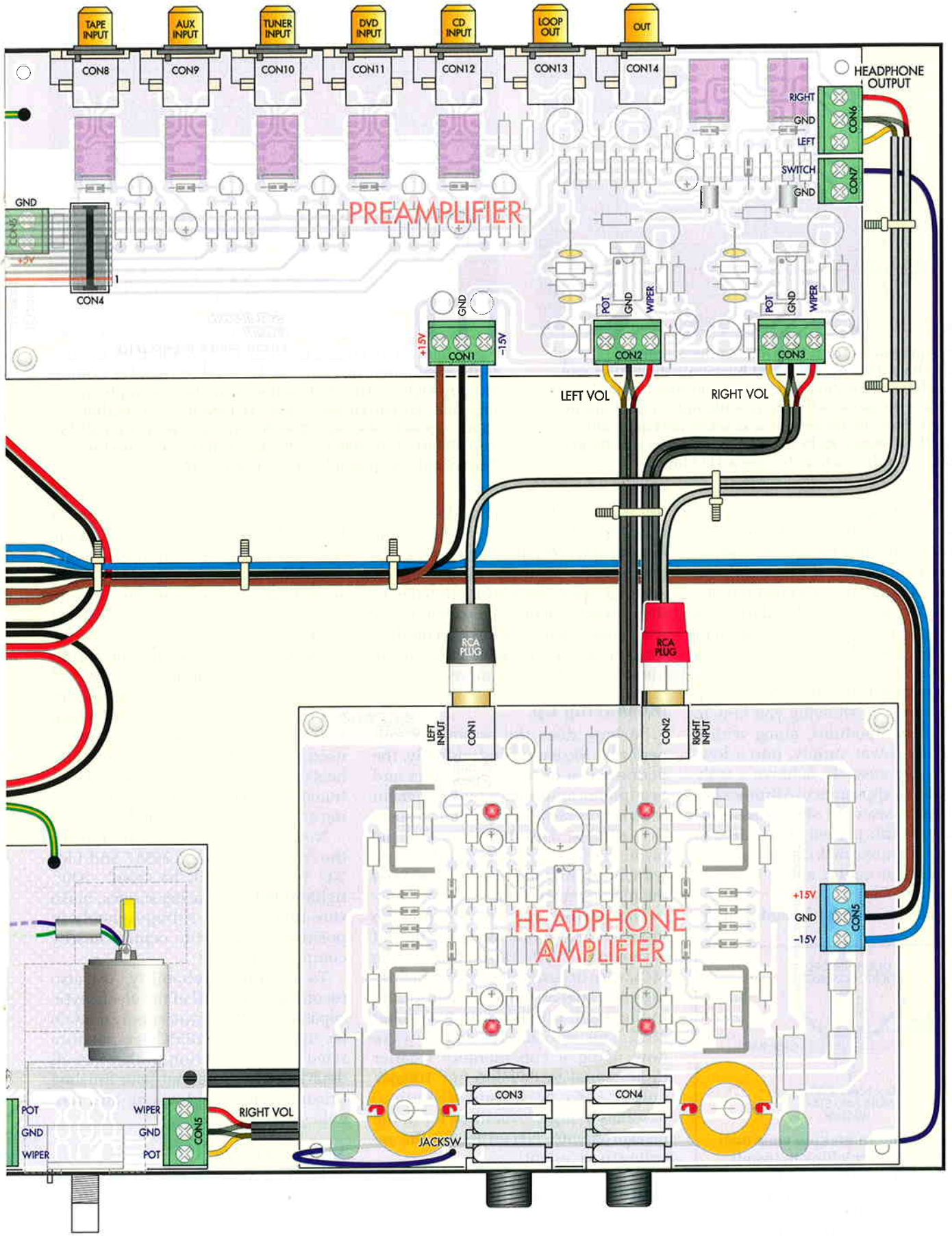


Fig.2: follow this basic wiring layout to assemble your unit. Note in particular that all 240VAC mains terminations must be fully insulated and no low-voltage wiring is to be routed on the mains (left) side of the metal partition. The headphone amplifier is mounted on 10mm spacers, whereas all other modules use shorter 6mm types.


TAPE INPUT
AUX INPUT
TUNER INPUT
DVD INPUT
CD INPUT
LOOP OUT
OUT
CON8
CON9
CON10
CON11
CON12
CON13
CON14
HEADPHONE OUTPUT
RIGHT
GND
LEFT
CON6
SWITCH
GND
CON7
PREAMPLIFIER
GND
+5V
CON4
GND
+15V
CON1
-15V
POT
GND
WIPER
CON2
POT
GND
WIPER
CON3
LEFT VOL
RIGHT VOL
RCA PLUG
RCA PLUG
LEFT INPUT
CON1
CON2
RIGHT INPUT
HEADPHONE AMPLIFIER
+15V
GND
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CON5
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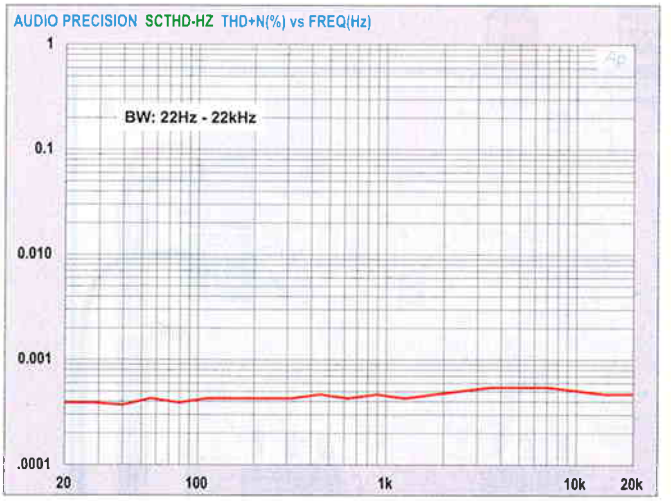

Fig.2: reproduced from the October 2005 issue, this graph reveals the extremely low total harmonic distortion and noise (THD+N) produced by the preamplifier module (the results are the same with the module both in and out of the case). This measurement was taken driving a 50kΩ load with a 600mV RMS input signal but the results are virtually identical when driving a 1kΩ load.

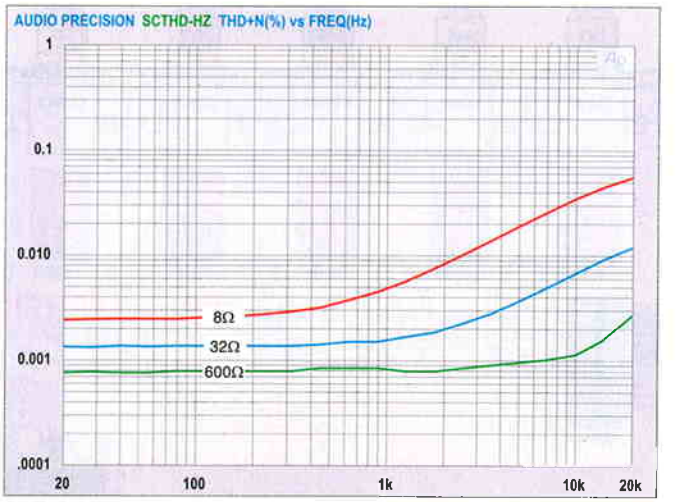

Fig.3: here we're measuring from one preamplifier input to the headphone output. The 32Ω and 600Ω cases exhibit slightly higher THD+N than the standalone headphone amplifier measurements, as we're now using a smaller input signal to develop 200mW into 32Ω (ie, 382mV RMS) and 100mW into 600Ω (ie, 850mV RMS) – so noise (not distortion) becomes a larger overall factor.

two pairs of higher impedance units.

Then in April this year, we provided details of an infrared remote control module to mate with the preamplifier. Using virtually any universal remote, this module allows you to take charge of the preamp from your lounge chair – an indispensable addition to any audio setup!

As promised, this month we wrap up the series by showing you how to install these modules, along with a low-noise power supply, into a low-profile steel case. To achieve a truly professional appearance, Altronics has produced a laser-cut steel chassis especially for this project. It is similar to their "1U" deluxe rack cases, featuring 2-piece construction and a bevelled front panel.

Unlike the standard catalog item, this custom design includes an internal divider for the 240VAC mains section and is finished in an attractive grey metallic paint. Naturally, the front and rear panels are screen printed with the necessary labelling, so you know what goes where. The finished product looks a lot like what you see in the photos – need we say more?

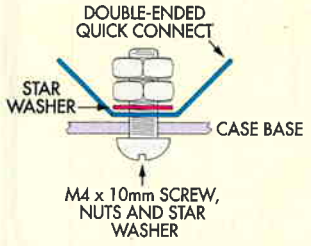

Fig.4: if you're making your own enclosure, here's how to install the chassis earth point. Two nuts are used to permanently lock the assembly in place. Make sure that it forms a sound electrical contact with the steel base.

Measuring up

So how does the assembled unit perform? Measured individually, the performance of the preamplifier and headphone amplifier modules remain the same as described in their respective articles. This indicates that the layout within the case works well, with no additional noise induced from the mains transformer.

The performance of the preamp input to headphone amplifier output is shown in Fig.3. As you can see, the 600Ω case in particular reveals slightly higher THD+N measurements than in the graph published in November 2005. This is to be expected, as we're now using a considerably smaller input signal to develop our 100mW output – so noise (not distortion) becomes a larger overall factor in the measurements. Nevertheless, the results are excellent!

Cooling down

During testing of the completed assembly in a 1U rack case, we were initially concerned about the temperature rise of the power supply module in high ambient temperatures. This issue was resolved by machining additional ventilation slots above and below the supply. We recommend that you do the same if you decide to construct your own case.

As noted in the headphone amplifier article, it's imperative that all three of the voltage regulators are fitted with heatsinks. To maximise heat transfer, insulation pads must **not** be used between the regulators and their heatsinks. Instead, a thin smear of heat transfer compound is used on the mating surfaces before assembly.

Note that without insulating pads, the heatsinks of the LM317 and LM337 regulators will be "live". After tightening the securing screws, make sure that they are sitting squarely in position, so as not to contact nearby components.

To maximise reliability, we also recommend that all of the electrolytic capacitors in the power supply module be upgraded to 105°C temperature rated types. Attention to these small details will ensure that your finished preamplifier provides long and reliable service.

Mains wiring

We'll start by hooking up the 240V AC wiring in the unit – see Fig.1. As shown, all the mains wiring is located in the partitioned-off area in the lefthand side of the case. In fact,

this area is reserved exclusively for mains wiring!

Fit the transformer first, noting that the large flexible washer supplied with the unit must be installed between the transformer and chassis. Orientate the transformer so that the wires exit at the top, with the primary (brown and blue) wires nearest to the rear of the case – see Fig.1.

The secondary side terminations (orange, black, white and red wires on the Altronics transformer) can now be fed through the grommetted hole in the partition, ready for connection to the power supply board. Position all the wires so that there will be plenty of clearance to the lid when it is installed later.

We expect that the Altronics case will already have a suitable chassis earth point, consisting of a double-ended 6.3mm spade lug fastened securely to the base. If you're building your own enclosure, position the lug approximately as shown and attach with an M4 x 10mm screw, shakeproof washer and two nuts – see Fig.4 for details.

Next, slip the mains rocker switch and IEC socket into their respective cutouts, noting that the earth pin side of the socket must be closest to the chassis earth point. You can now run and terminate the mains wiring. Use only 7.5A or 10A/250VAC mains-approved cable for all connections.

The Active (brown) lead from the transformer will be long enough to extend forward to the switch, with an additional length of brown and yellow/green cable needed to complete the switch and earth point wiring, respectively. Use small cable ties where applicable to keep everything neat and tidy. Refer to Fig.1 and the photos for all the details.

Do not solder the wires directly to the switch or socket pins! These devices are not designed to withstand the high temperatures seen during soldering and may be damaged. Instead, terminate each wire end in a fully insulated 6.3mm female spade crimp terminal.

Note that a ratchet-driven crimping tool is required for this job. Low-cost automotive type crimpers are not suitable and their use will result in unsafe connections.

Once the mains wiring is complete, go back and check that each connection is secure and well insulated. If necessary, use heatshrink tubing to completely cover any exposed terminations. That done, use your multimeter to check for continuity between the earth pin of the IEC socket and any convenient point on the chassis that is devoid of paint, such as the countersunk screws in the side panels.

This test must be repeated later when the top panel of the case is fitted. At that time, use your meter to check that the top and both side panels are earthed. If not, carefully remove the paint from beneath the heads of the retaining screws to ensure a reliable connection.

Module installation

The modules may be installed into the case in any order, although you may find it easier to leave the headphone amplifier until last. The audio cable passes beneath this module on its way to the remote control module.

To avoid hiccups, careful attention must be paid to the following points:

- Adjustments to the lead bend of the LEDs and infrared receiver on the remote control module will be required to get everything in line. Ideally, the LEDs should all protrude through the panel by the same amount, while the body of the infrared receiver should just contact the rear of the panel.
- If the infrared receiver includes an external metal shield (see photo), then steps must be taken to ensure that it is insulated from the chassis. We suggest a short strip of ordinary insulation tape on the inside of the front panel, with a hole cut out to match the hole in the panel. Do not rely on the paintwork to provide insulation!
- All modules apart from the headphone amplifier are mounted atop 6mm untapped spacers and held in place using M3 x 10mm screws, shakeproof washers and nuts. Use taller 10mm spacers for the headphone amplifier only.
- Although the preamplifier PC board has four 3mm corner mounting holes, only two of these are used to attach the PC board to the base of the chassis. The other end of the board is held firmly in place by the RCA sockets, which are attached to the rear panel via seven self-tapping screws. Similar mounting arrangements apply to the headphone amplifier and remote control modules

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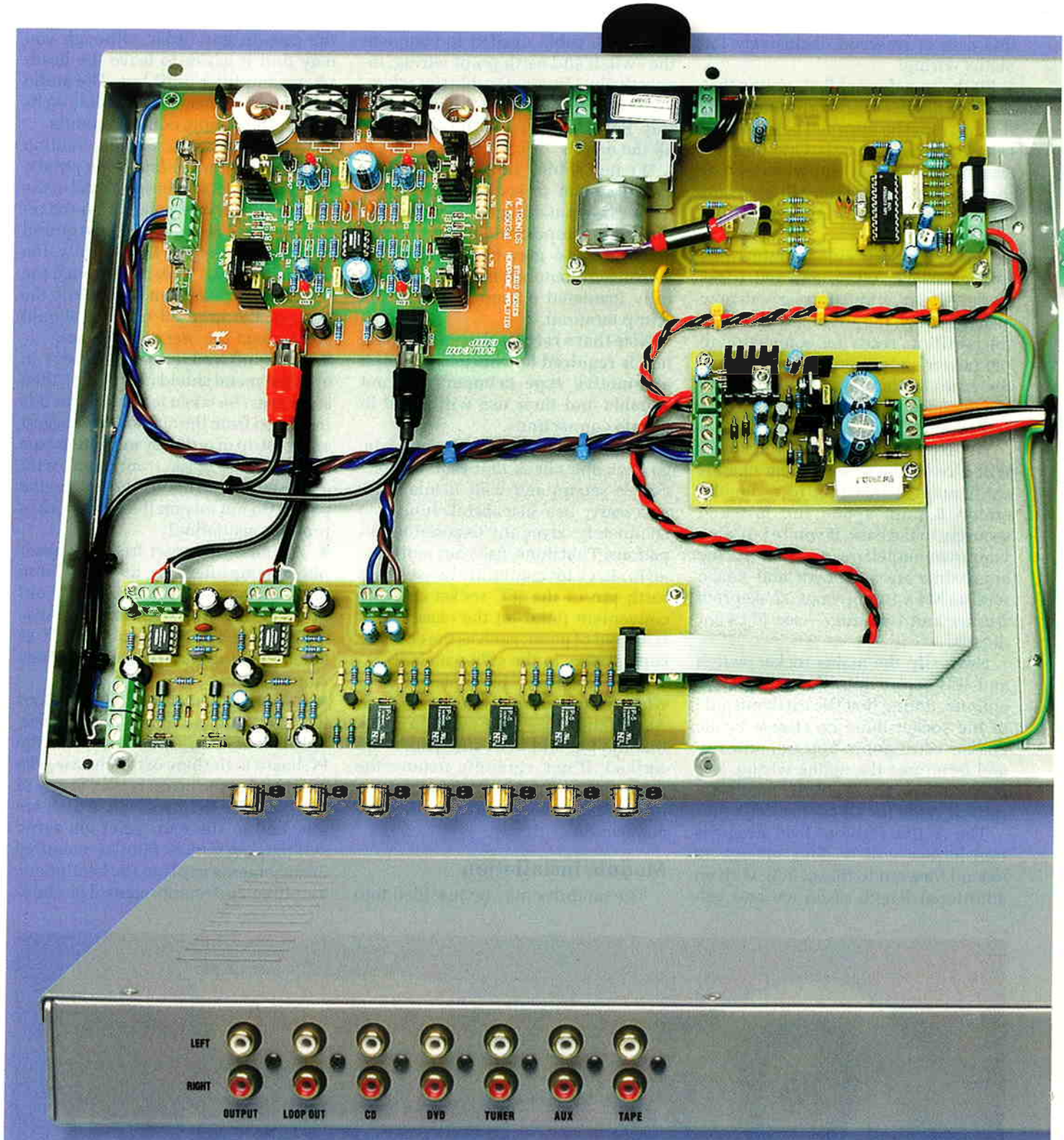
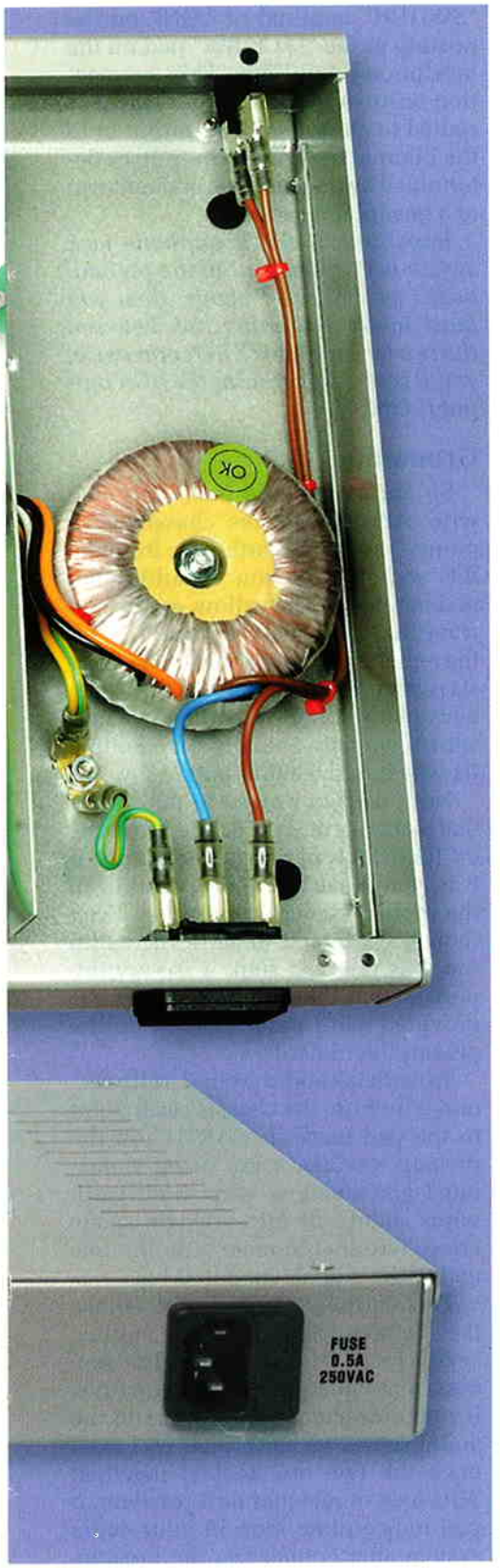


Top: the supply wiring to the various modules is twisted together to improve the appearance and reduce noise. Note the dress of the flat IDC cable between the preamp module and the control module. Bottom: the self-tapping screws that secure the RCA sockets should be tightened before the two chassis-mounting screws for this module.

– only the pair of holes furthest from the front panel should be used for mounting.

- For the three main modules, fit the base-mounting screws first, winding on the nuts so that they're only finger tight. Next, make sure that each module is in firm contact with the front/rear panel and fit the nuts or screws on the pot shaft, jack sockets or RCA sockets, as appropriate. The idea is to tighten everything gradually, so that no stress is placed on board-mounted components.
- Don't tighten anything up just yet anyway – you'll almost certainly need to remove one or more boards to run cabling underneath and to get access



Parts List For Complete Preamplifier

1 1U high steel case with internal divider
1 32mm black aluminium knob with grub screw (Altronics H 6236)
1 15V+15V 30VA (or 20VA) toroidal transformer (Altronics M 4915A)
1 SPST 6A 250VAC slimline rocker switch (Altronics S 3202)
1 snap-in fused male IEC socket (Altronics P 8325)
1 M205 500mA 250VAC slow-blow fuse
1 240VAC 3-pin IEC mains power lead
1 6.3mm double-ended chassis-mount spade lug
7 6.3mm female spade insulated crimp connectors

Modules

1 preamplifier module (Altronics K 5502)
1 power supply module (Altronics K 5501, Jaycar KC-5418)
1 headphone amplifier module (Altronics K 5503, Jaycar KC-5417)
1 remote control module (Altronics K 5504)

Wire & cable

470mm heavy-duty red hook-up wire
470mm heavy-duty blue hook-up wire
470mm heavy-duty brown hook-up wire
940mm heavy-duty black hook-up wire
400mm light-duty purple hook-up wire
650mm figure-8 shielded audio cable (Altronics W 3022)
250mm 7.5A 250VAC brown wire for mains cabling
650mm 7.5A 250VAC green/yellow wire for mains cabling
40mm length of 3mm bore heatshrink tubing
2 10-way IDC cable-mount sockets
390mm 10-way IDC ribbon cable
14 small nylon cable ties

Mounting hardware

7 self-tapping screws (supplied with the RCA sockets)
8 M3 x 6mm untapped spacers
2 M3 x 10mm untapped spacers
10 M3 x 16mm pan head screws
10 M3 shakeproof washers
10 M3 nuts
1 M4 x 10mm screw
1 M4 shakeproof washer
2 M4 nuts

Where To Buy Complete & Shortform Kits

A complete kit of parts for the preamplifier – including the four modules (power supply, preamp, headphone amplifier and remote control) and a pre-punched steel chassis similar to that shown in the photographs – is available from Altronics, Cat. K-5500. The price at time of publication was $299.00. Alternatively, you can purchase a shortform kit that includes just the chassis, transformer and other hardware (but not the PC boards or on-board components) for $154.00 (Cat. K-5500S). Check them out at **www.altronics.com.au** or phone 1300 780 999 to order.

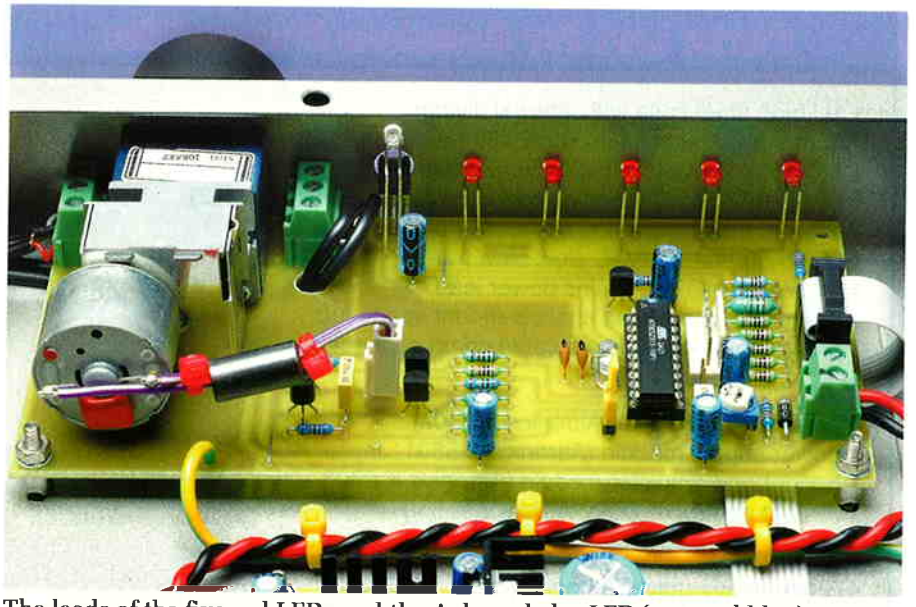
Note: the infrared remote control handpiece must be purchased separately. We used an Altronics AIFA Y2E (Cat. A 1013) with the prototype but almost any universal remote should be suitable.

to the terminal blocks for the audio cable wiring.

Low-voltage wiring

Now for the low-voltage wiring. First, trim the secondary leads of the transformer to the right length, scrape the insulating enamel off the ends and tin them with solder. You should have about 8mm of nicely tinned wire protruding from the spaghetti tubing. That done, twist one start and one finish lead of each winding together to form a centre tap (the black & white leads on the Altronics transformer) and connect all three leads to the power supply module's AC input (CON1).

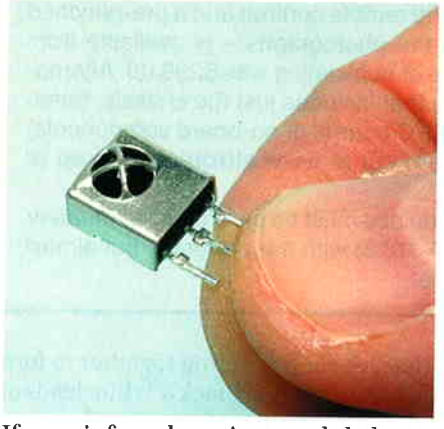
Before connecting anything to the



The leads of the five red LEDs and the Acknowledge LED (we used blue) are bent at right angles, so that they go through their matching front panel holes. Similarly, make sure that the infrared receiver module lines up with its hole and is flush with the rear surface of the front panel.

output of the supply, power up and measure the three rails at the supply outputs (CON2 & CON3). Assuming all is well, the +15V, -15V and +5V rails should all be within ±5% of the rated values. Now switch the power off and physically disconnect the 240VAC mains lead to prevent accidents while working under the hood!

The ±15V and 5V cabling for all of the modules can be run next. Use heavy-duty, multi-strand hook-up wire for the job and twist the wires tightly together to reduce noise and improve appearance. Be sure to use the exact connection arrangement shown, with each module having its own set of power leads back to the power supply outputs.



If your infrared receiver module has a metal shield like this one, then be sure to insulate it from the front panel as described in the text.

Prepare each wire end by stripping off about 10mm of insulation. Tin the bare ends with solder and then trim them to about 8mm in length. If you've done it right, you should be able to fit two wires into one terminal block hole.

Audio wiring

All audio connections are made using twin (figure-8) shielded cable. Run the cable between the volume pot and CON2/CON3 on the preamplifier module first, positioning it beneath the headphone amplifier. The "left" volume cable should be fed through the large hole just to the rear of CON4 on the remote control board. We've labelled the terminal block connections "WIPER", "GND" and "POT" to make identification easy.

To prepare each wire end for connection to its terminal block, strip off about 18mm of the outer insulation, then twist the two shield wires tightly together and tin them with solder. An 8mm length of small heatshrink tubing can then be slipped over the shield wire to improve its appearance. Finally, strip about 8mm of insulation off the red and white wires and tin these as well.

The connections to the headphone amplifier inputs are made with RCA plugs so fit these to the cable ends first before wiring the far ends to CON6 on the preamp module. Finally, run a single light-duty wire from the "SWITCH" terminal of CON7 on the preamp to the "JACK SW" pad on the headphone amplifier. This connection ensures that the audio signal is routed to either the RCA output or to the internal headphone output, as determined by the insertion and removal of a headphone jack.

Important: if the headphone jack switch isn't connected to the preamp board as described above, then you must insert a shorting link between the two terminals of CON7; otherwise, you'll get no signal from the RCA output (CON14)!

Grounding

So far, you should have only one wire connected to the chassis earth point – the mains earth wire from the IEC socket. Now run an additional mains-rated green/yellow earth wire from the point marked "EARTH" on the remote control module to the chassis earth point. This solidly earths the body of the volume control pot to prevent motor hash or mains hum finding its way into the audio path.

Next, use your meter to make sure that mains earth is not connected to the 0V (GND) rail of the power supply. If it is, you'll need to find the source of the problem before continuing. Even though we intend to earth the audio input as the next step, it is very important that this occurs only via the provided earth point marked on the preamplifier board.

To earth the audio ground, run a second wire from the chassis earth point to the pad marked "EARTH" on the preamp module, again using mains-rated green/yellow wire. Both earth wires should fit into a single spade crimp terminal to mate with the free end of the chassis-mounted lug.

This earthing method will reduce the chances of creating an audible "earth loop" in your system but success is not guaranteed! For example, if your power amplifier also earths the audio signal, an earth loop will exist once the two are hooked together. This may or may not be a problem. If you notice more hum in your audio system after connecting the preamp, then try disconnecting the earth wire to the preamp module. **Never, ever disconnect the mains earth from the chassis!**

Well that's about it. We hope you enjoy listening to your new preamplifier! SC

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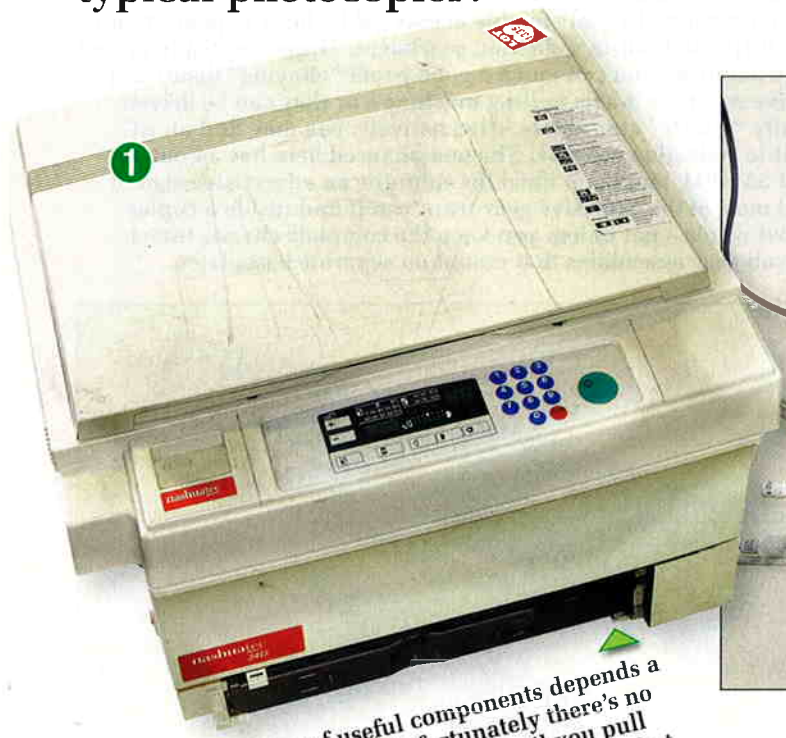
Salvage It!

BY JULIAN EDGAR

There's lots of good bits inside junked photocopiers

If you haven't noticed, these days you can pick up used photocopiers for a pittance. Nope, not pretend little desktop photocopiers but the full-size office monsters that weight 40kg or more. Some are working, some aren't – but when you pay less than $15, all are excellent salvage value! So what bits and pieces can you get out of a typical photocopier?



The quality and number of useful components depends a lot on the specific photocopier. Unfortunately there's no way of knowing exactly what you've got until you pull it apart. Some have as many five DC brushless fans – but some have only two. Some photocopiers have large stepper motors, while others use synchronous AC motors which are much less useful. So although the salvaged components might be well worth $50 (or much more), because of the uncertainty, it's wise to not spend more than $10-$15. The photocopier pictured here was bought by tender for just $15.00

Inside all photocopiers you'll find lights and fans. The lights – high voltage, high power incandescent filament bulbs – are used to both illuminate the material to be copied and also as a heater to cook the toner as the photocopied sheets are on their way out of the machine. The latter light often includes an over-temperature switch mounted nearby. In addition, you'll sometimes find rows of mains-powered neon lamps and/or rows of low-voltage LEDs. Fans consist primarily of conventional PC-type fans (although often running on 24V – but they'll work down to 12V without problems) but sometimes – if you get lucky – you'll find a bunch of squirrel-cage fans of the sort that move a lot of air very quietly. These are usually AC mains-powered but a few work on 24V DC.

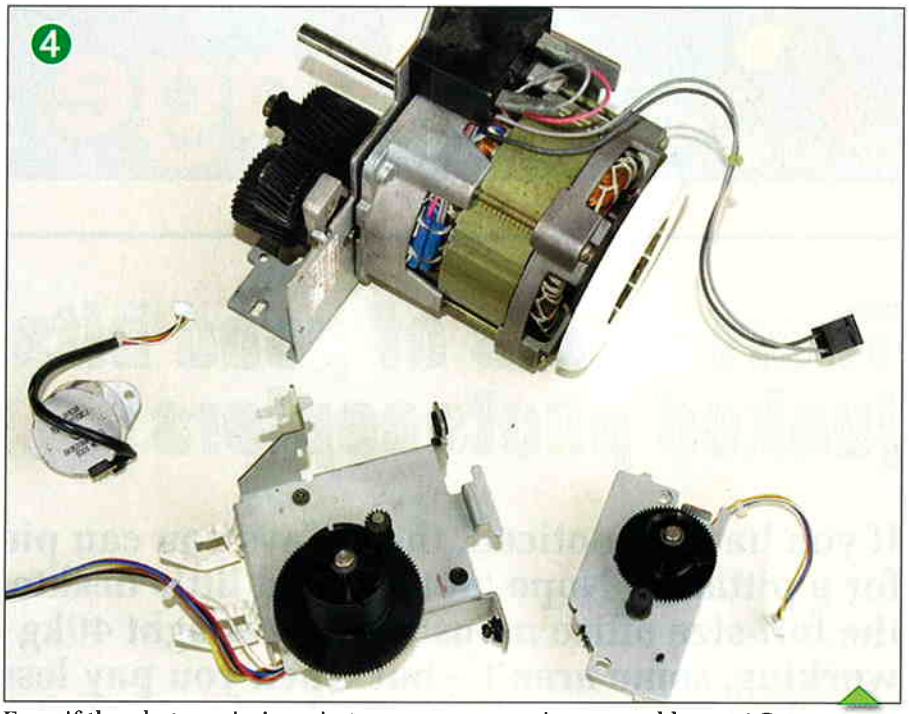
You can also be guaranteed of finding an excellent quality lens (typical focal length = 180mm) and a number of mirrors. The lenses are razor sharp and make ideal hand magnifying glasses – they're also large and bright and some are coated for better light transmission. The mirrors are front-faced and their length corresponds to the width of the photocopy area. Typically, they're 10-20mm wide, so they're long and narrow. To be honest I haven't found a lot of use for them (except, oddly enough, winding high powered resistors on them!) but if you're into lasers or other optical systems and need very low-cost, high-quality mirrors, they should do the job quite nicely!

Rat It Before You Chuck It!

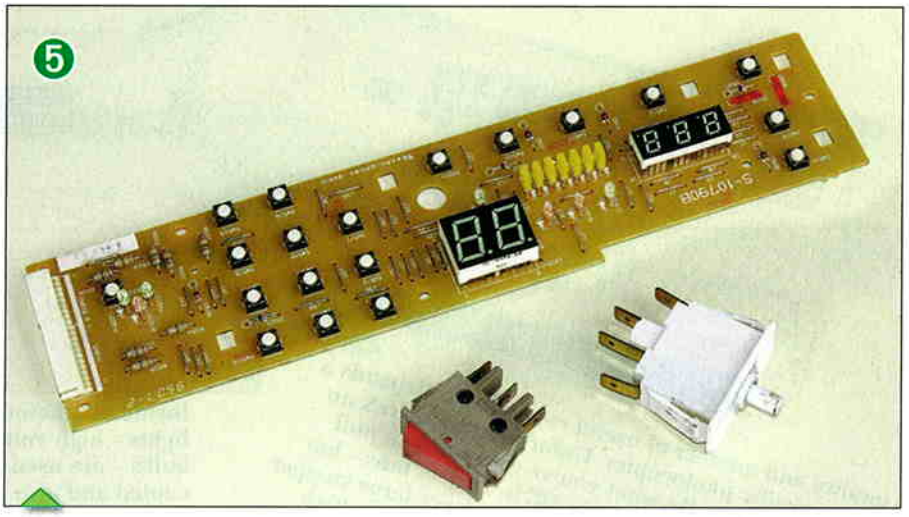
Whenever you throw away an old TV (or VCR or washing machine or dishwasher or printer) do you always think that surely there must be some good salvageable components inside? Well, this column is for you! (And it's also for people without a lot of dough.) Each month we'll use bits and pieces sourced from discards, sometimes in mini-projects and other times as an ideas smorgasbord.

And you can contribute as well. If you have a use for specific parts which can easily be salvaged from goods commonly being thrown away, we'd love to hear from you. Perhaps you use the pressure switch from a washing machine to control a pump. Or maybe you salvage the high-quality bearings from VCR heads. Or perhaps you've found how the guts of a cassette player can be easily turned into a metal detector. (Well, we made the last one up but you get the idea . . .)

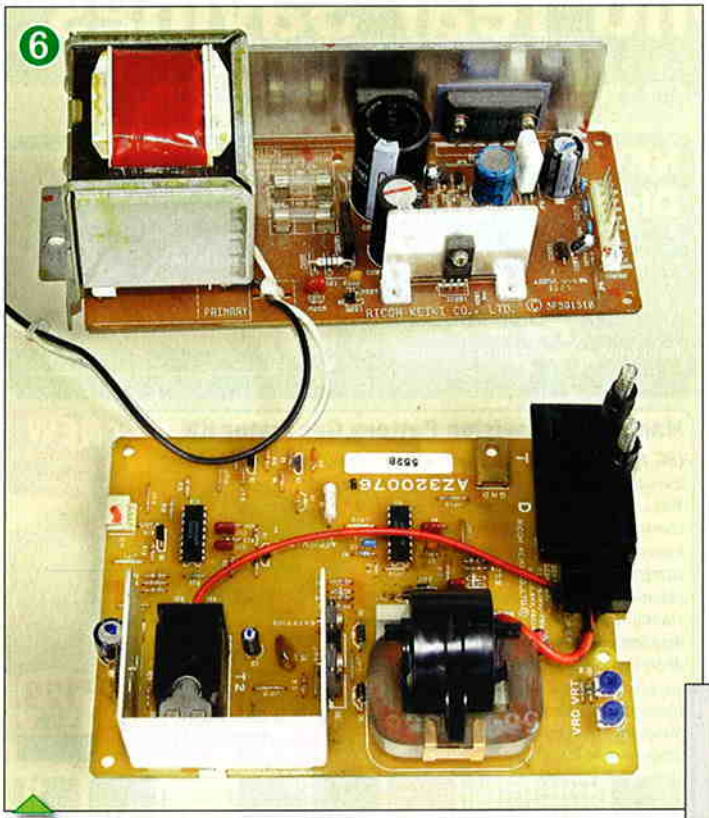
If you have some practical ideas, write in and tell us!



Even if the photocopier's main transport system is powered by an AC motor, there will still be a few low-voltage stepper motors inside. For example, if the copier uses a document feeder, there'll be a stepper buried in that part of the machine. However, occasionally you stumble across gold – huge stepper motors (as big as a man's fist) with built-in reduction gearboxes. These are highly prized (and if you don't want them, you can make a good profit "eBaying" them) and can be used to drive robots or 3-axis milling machines, or they can be driven backwards as really "grunty" alternators. Alternatively, you may find an AC motor with a built-in reduction gearbox. The one pictured here has an output shaft speed of just 53 RPM, making it ideal for spinning an advertising sign or the like. Note that most of the extensive gear-train you'll find inside a copier cannot be extracted whole – not unless you keep the complete chassis intact. Instead, look for sub-gear assemblies that mount on separate baseplates.

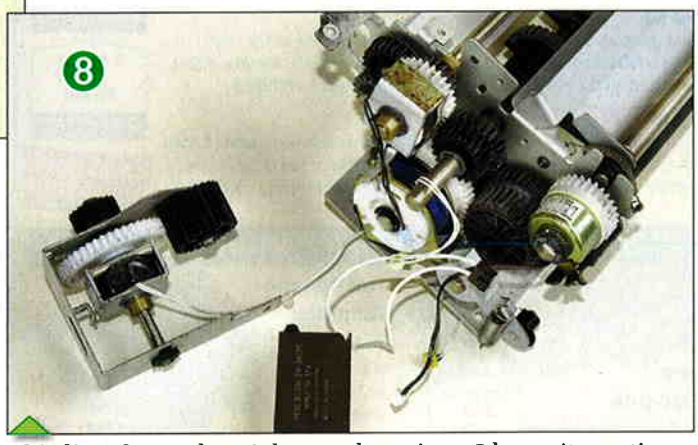


There are two completely different classes of switches inside photocopiers. The most numerous are the tiny tactile PC-mounted pushbuttons which are located behind the membrane keypad. By using a heatgun directed at the solder side of the PC board and a pair of pointy-nosed pliers to pull them out, a lot can be salvaged in a very short time. There will also be another pair of switches with very different current ratings to the pushbuttons – the main on/off switch (normally on the back of the photocopier) and a pushbutton switch that goes open-circuit when the top half of the copier is pivoted up for repair or toner replacement. The latter two switches are definitely worth salvaging – they are heavy duty with typical ratings of 16A at 250V AC.



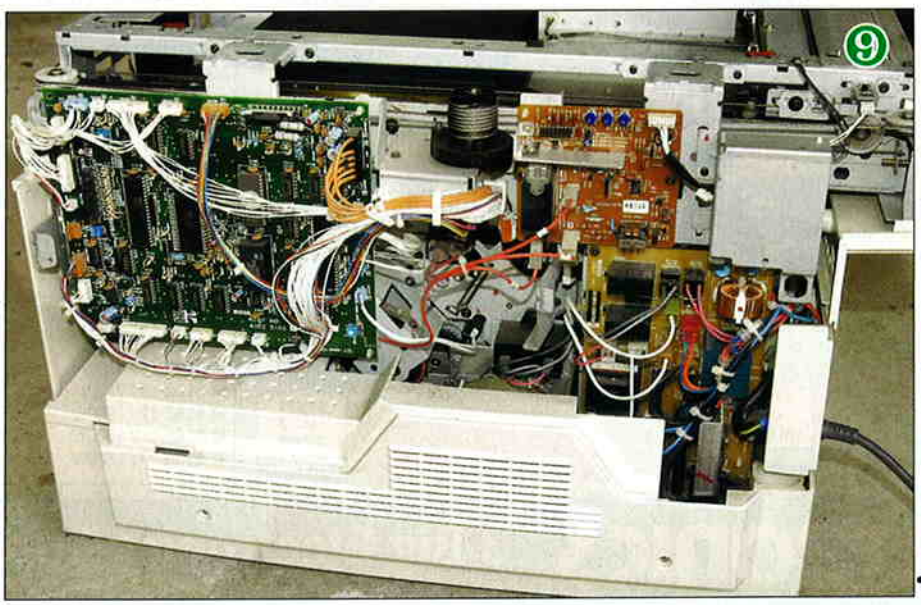
Think "photocopiers" and you're probably immediately thinking of high-voltage power supplies. After all, photocopiers use kilovolts inside! However, while the power supplies are able to be salvaged (most copiers have at least two HV power supplies), there aren't too many practical uses for a power supply with an output of just 290µA at 5kV! In addition, there's also usually a conventional linear power supply, typically providing 5.2V at 0.4A and 1.6A at 24V. If you decide to strip these rather than use them whole, you'll find a range of medium and small aluminium heatsinks that are easily removed. Make sure that any high-voltage capacitors are completely discharged before touching them.

There's also a whole lot of hardware that's worth scrounging. The fold-down lid often uses snap-action 2-position hinges, there are hundreds of machine screws, many springs, pulleys, cables and toothed belts, and a bunch of cogs and gears. There's also something potentially even more useful – painted or plated sheet metal brackets and panels. These are ideal if you need to construct custom brackets, make a new faceplate panel or similar. And don't forget the glass: it's usually very easy to remove (do it first so there's less chance of breaking it!).



This list of parts hasn't been exhaustive – I haven't mentioned the LED displays, the electro-mechanical counter, the electric clutches, bearings or shafts. There are usually plenty of good bits to salvage. But even if you don't keep a lot of stuff, pulling apart a photocopier is a fun exercise in itself. It's fascinating to see how the engineers have fitted a complex machine into a compact package.

When you're pulling apart a photocopier, there are a few precautions to keep in mind. First, disassemble the copier outside while wearing old clothes – inevitably, toner will get everywhere. Second, some copiers use torsion bar springs to counterbalance the weight of the open top half. These springs are very powerful and if you undo their retaining screws while they're under tension, they can fly out and possibly cause injury. Other copiers use small gas struts – another excellent salvage part. **Finally, the high-voltage power supplies have on-board capacitors that could give a nasty bite – they should be OK if the copier hasn't been powered-up recently but keep it in mind or you could get a nasty shock.**



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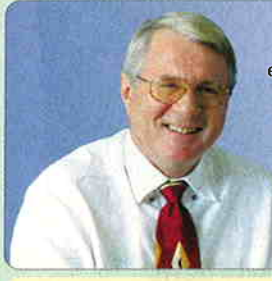

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Jack O'Donnell - Managing Director

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Complete Kit:
Every bit as good as a commercial unit, but at just a fraction of the cost! Available as a full kit comprising of all PCB modules, chassis, toroidal mains transformer and all the parts required for a complete unit! - **K 5500**

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Chassis Pack:
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STUDIO SERIES PRE-AMP MODULES:

Pre-Amp Input Module
Utilising the latest ultra low noise high performance op amps. Featuring 5 RCA inputs plus easy integration with the headphone amplifier & power supply module. **Unbelievably low 0.0005% distortion!** Supplied with PCB, components, input rotary switch, volume pot & cabling.

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Ultra low noise, low distortion design. Drives high and low impedance headphones. Great for those requiring a bit more listening "oomph" from their portable MP3 player or CD player. Features dual headphone outputs.

$29.95 K 5503 NEW KIT!

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A low noise linear power supply module to suit the Silicon Chip Studio Series Pre Amp. Easy to build and integrate into your pre amp project!

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Add the latest module to your studio pre amp project. This board allows volume adjustment and input switching via infra red remote.

$59 K 5504 NEW KIT!

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NEW Only available at Altronics!

(SC June 2006) ***ATTENTION: AV Installers, Service Technicians, Television Repair People!***

This compact, portable generator creates 9 commonly used test patterns which are easily displayed on any device with a composite video input, ie: projectors, plasma, lcd, CRT televisions etc. The standard patterns (shown below) allow easy diagnosis of commonly found video image distortion problems. It fits right in your hand, is easy to build, and is powered by a 9V battery! Great for working on ceiling mounted projectors. Includes programmed PIC chip.

A must have for video servicing and trouble shooting in the field or workshop!

$129 K 2725 BARGAIN!

Sturdy All Aluminium Equipment Case

Great for camera gear, CD's , tools or any essentials you need on the road! Robust all aluminium construction with a stylish polished finish.

OVER 30% OFF!

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Great value! SAVE OVER 25%. This handy service pack includes everything you need for electronics servicing, including: Compressed air, contact cleaner, cleaning solvent and isopropyl alcohol.

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*Note: Must be freighted by road.

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PICK UP A BARGAIN! We have strictly limited stocks of these high performance inverters for a drastically reduced price!

All are covered by a **FULL ONE YEAR WARRANTY** from date of purchase. Some are missing packaging or have minor marks and scuffs that prevent them from being resold at full price.

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M 8112 12V 250W	$149	$74.50
M 8116 12V 380W	$179	$89.50
M 8117 24V 380W	$189	$94.50
M 8122 12V 430W	$239	$119
M 8132 12V 720W	$349	$174
M 8142 12V 1300W	$699	$349
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HURRY STOCKS ARE VERY LIMITED! THESE WILL BE GONE IN NO TIME!

Power your laptop on the road!

(12V Input) Simply plugs into your cars accessory socket and provides power to a laptop. Selectable output voltages 15, 16, 18, 19, 20, 22 and 24VDC, up to 3.5A (regulated). Supplied with 6 adaptors to suit most laptops.

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Check Out These AV Specials...

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Great for MP3 players or hi-fi use

In-ear buds
- Superb reproduction
- Excellent noise reduction
- Retractable cord, 3.5mm plug

GREAT SOUND FOR UNDER 20 BUCKS!

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Stylish Hi-Fi Headphones
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2 for $12 P 6827 RRP $9.95 — Component video!

2 for $14 P 6803 RRP $11.95 — 4 Way Speaker!

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A great way to mount a small telly, computer or security monitor to your wall, increasing your desk space in the process! Features a swivel arm bracket with 15° tilt adjustment. 30kg max, 300 x 280mm base plate.

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A compact 2 way stereo / 3 way mono plus subwoofer active crossover. Designed to integrate into multi amplifier systems to provide plenty of flexibility and adjustment. All inputs and outputs are balanced XLR's. 45Hz to 960Hz adjustment (450Hz to 9.6KHz with 10x selected), plus 20Hz-200Hz subwoofer channel.

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Finished with industrial grade high gloss powdercoating

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Neaten up your AV system forever! These remote control AV switchers allow you to switch up to 3 inputs to one output. Great for switching between game consoles, camcorders, DVD, DVDR etc.
A 3070: SVHS, Composite, RCA and optical (toslink) inputs/outputs.
A 3071: RGB, RCA and optical (toslink) inputs/outputs.

$125 A 3070 SVHS A 3071 RGB RRP $148

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Save up to 35%. Excellent value for money!

Our most popular speaker range. Featuring a long lasting coated paper cone, designed for superior strength & reliability. See catalogue or website for full specs. All 8 ohm.

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C 3024	200mm 60W	$69ea	$85
C 3026	250mm 100W	$89ea	$110
C 3030	300mm 80W	$109ea	$160
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Relay your remote control signal from one room to another. Turn your music up in the bedroom, even if the amplifier is in the lounge! Range up to 100m line of sight. 30m through walls.

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Great for powering speakers in the study, patio or bedroom!

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Bargain priced 2 x 70W stereo receiver

An easy way to expand your home audio system, power up your speakers in the study or out on the patio.
Features: • 2 x 70W • RCA line level and phono inputs • A&B speaker switch • AM/FM tuner • Remote control.

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Store all of your music in one compact hi-fi unit

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Add an 80gb hard disk and you could have up to 8 weeks of continuous music! 12V operation and compact size means it can fit almost anywhere. Accompanied with the **K 5105** (pictured) 12V 15W stereo amplifier and you have a perfect bookshelf sound system. **Supplied in kit form.** *Not available from dealers.*

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"The Q 1264 will do everything you could possibly want, more accurately than you'll ever need" *Australian Hi-Fi Magazine*

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60W volume controller

AUSTRALIAN MADE!

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Unbelievable sound for their size! These mini cube speakers pack a punch in any hi-fi or home theatre system. Great as surrounds or just music extension speakers for entertaining areas. 3.5" speakers + tweeter. 20W RMS. 8Ω

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With genuine Sharp® TFT screen!

A fantastic addition car sound system! This 7" wide format LCD screen will amaze you with its clarity and sharpness. It displays TV stations via an inbuilt tuner or an AV input eg: DVD or camcorder. • Includes mounting bracket & remote • Runs off 12V, easy to setup & install • Slimline design

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Super quality picture!

Utilises a high quality CCD sensor for an excellent, low noise picture. This compact dome camera easily mounts to ceilings, under eaves etc. Camera angle can be quickly adjusted as required. M 9243 plugpack to suit $18

$65 S 9112A RRP $85

Compact reversing camera

This all metal colour reversing camera can be easily flush mounted into the rear bumper of any car, caravan or trailer. Connect it up to an in dash monitor for easy viewing.

$160 S 9134 RRP $199

Handy image flip function shows video as if viewed in your cars mirrors.

"Easy-Install" Video Door Intercom

Check who's at the door before opening it.

2 WIRE INSTALL

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SAVE UP TO $50!

$159 S 9412 B&W RRP $179

$329 S 9417 Col. RRP $379

Installs in just a couple of hours! No expertise required!

Customisable Rack Cases

SAVE 20%!

These pro quality cases allow internal subchassis to be mounted along the full width or height of the case. Great for test equipment, amplifers etc. Aluminium front & rear panels. Supplied with internal panel and 4 mounting strips.

$69 H 5038 2U RRP $89

$79 H 5039 3U RRP $99

Allows easy mounting of internal PCB's

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IDEAL FOR AUDIO PROJECTS!

$55 H 5012 2U RRP $65

Compact & Stylish Rack Cases

Superb quality finish for easy assembly. Tough powdercoated finish with raw (silver) aluminium front panel. Rear panel is aluminium for easy customisation to suit your equipment.

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Aussie made!

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For projects with style!

Stylish modern look with recessed & bevelled front panel. Available in 1U or 2U. Powdercoated in black.

Hi-performance 20A, 3-30V power supply

Regulated precision for voltage critical devices

$300 M 8212 RRP $369

Compact switchmode design is both powerful and lightweight. Great for powering communications equipment, car audio amplifiers, camping fridges or other portable DC power appliances. 3 to 30V regulated output @ 20A max.

BARGAIN 15A 9-16V benchtop power supply

SAVE $50!

This compact, fan cooled, switchmode power supply delivers up to a huge 15A regulated output, adjustable between 9 and 16V. **Its great for powering comms equipment, scanners!**

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Multivoltage supply

25% OFF! Selectable 3, 4.5, 5, 6, 7.5, 9 & 12V. Produces 4A (3-6V), 3A (7.5V-9V), 2.5A (12V) output. Includes 6 tips for a majority of appliances.

$29 M 8232 RRP $39

With jumbo 'easy-read' display & arm band.

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Measures your systolic/ diastolic pressures and heart rate. Provides a simple way to get fast and accurate blood pressure readings. Stores 30 readings for up to 3 individuals.

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$29.95 A 0340 NEW PRICE!

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A handy way to keep a backup of your phone contacts. Very simple to use, simply insert a SIM card and press backup! Stores up to 250 phone contacts.

$15 X 5000 RRP $19.95

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TRUE RMS Datalogging DMM with RS232

The full house multimeter, packed with features and value! Excellent for R&D, service work and scientific applications. **Features:** • Dual display (frequency, AC voltage & temperature) • 10 Location memory • Time mode with alarm, clock and stop watch • MIN, MAX, AVG and relative modes • Decibel • Capacitance and inductance • Temp. mode (°C/°F) • Pulse signal injection function for logic and audible testing, etc • Continuity and diode test • Logic test • Fused 20A input • Data hold and run mode

$179 Q 1098 RRP $199

Hugely popular unit, thousands in use! A professional DMM at an affordable price!

Autoranging Datalogger

with optically isolated RS232

The Brymen® BM202 digital multimeter has features usually found in meters 2 or 3 times the price! Datalogging feature is great for monitoring charge rates, temperature variations etc. • Auto ranging • EF mains detect • Data hold • AC/DC voltage • AC/DC current • Frequency • Resistance • Diode check

BONUS! Q 1082 RS232 optical PC interface lead & software to suit, **valued at $24.95**

$149 Q 1080S HOT PRICE!

Precision benchtop multimeter

SAVE $50!

Great for the workbench or service department.

Featuring a jumbo backlit display for easy reading, this feature packed precision multimeter provides true RMS measurement, datalogging, USB/serial PC interface and much more! 240V or battery powered (6 x C Cells). • 10A AC/DC • Frequency to 50MHz • Software, temp probe, PC interface leads included

$299 Q 1520 RRP $349

Keep your pool or fish tank balanced

Easy-check PH Meter

25% OFF!

Why mess around with chemical testers or inaccurate litmus paper? This compact pH meter provides an instant readout of water conditions without fuss! Great for pool or fish tank owners. pH neutral buffering solution included.

$50 Q 1295 RRP $69.95

$14 P 0406 RRP $16.95

Pro grade test probes

Superb construction for long service life. Soft silicon rubber sheath & handles. Cat 3 1KV 10A approved.

High performance ultrasonic cleaner

SAVE OVER 30%

Clean the tiniest of items without harsh solvents. Great way to clean mum's jewellery! No need for nasty solvents or harsh abrasives! This cleaner uses water and household detergent, coupled with ultrasonic waves to clean even the tiniest of items without damage. Features a 167L x 90W x 55D stainless steel tank and a handy 1 to 9 minute timer.

$69 A 0103 RRP $99

Gently cleans computer connectors, PCBs, jewellery, glasses, watches, fuel injectors and other very fine parts.

21 range Digital LCR Meter

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This super accurate LCR meter is perfect for developing audio crossovers, switchmode power supplies, resonant filters & RF circuits. Allows quick measurements of inductance, capacitance and resistance. Test leads, carry case and holster included.

$80 Q 1154 RRP $99

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Non-contact pocket sized AC detector with LED flashlight. An essential for anyone operating with AC wiring or transformers. Lights up whenever it is near any AC source (100-600V @ 50-60Hz).

$20 Q 3002 RRP $25.95

A must have for electrical tradespeople!

Multifunction Pocket Tester

This tiny tester can perform a multitude of electrical tests, even tasks some $100 multimeters can't manage! Provides instant checks for: continuity, DC volts presence, microwave oven leakage and locating 240V AC wiring. Provides audible and visual feedback for each test. Batteries included.

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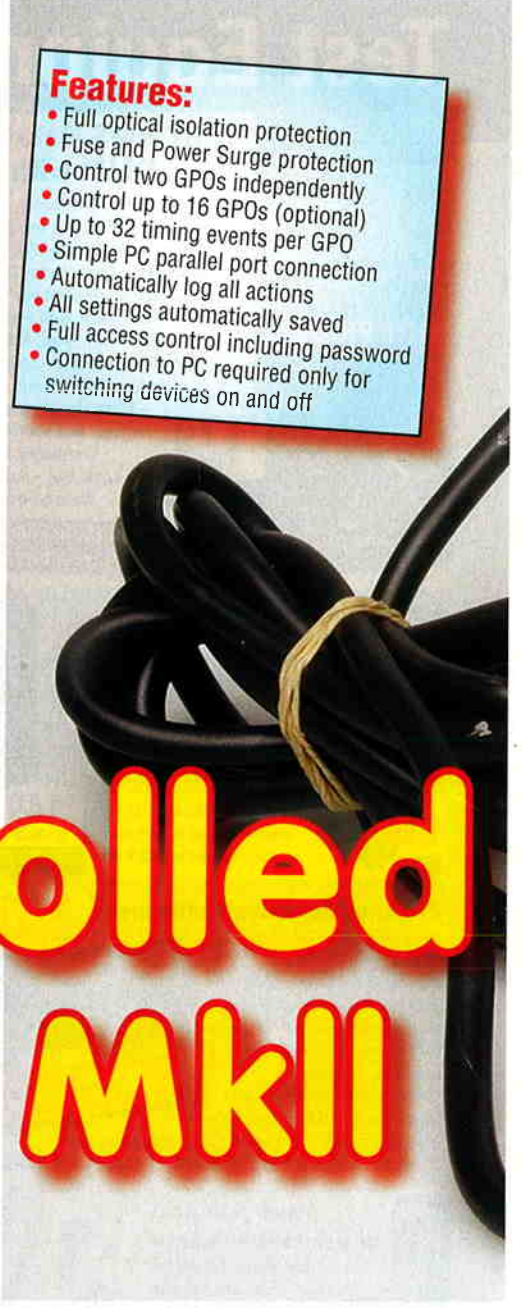
Ever wanted to control switched 240VAC outlets with your PC? You can do it with this project which controls two 240VAC outlets. You can switch virtually anything, at any time under full Windows control. It uses your computer's parallel port and virtually any old (or new) computer can do the job.

Features:
- Full optical isolation protection
- Fuse and Power Surge protection
- Control two GPOs independently
- Control up to 16 GPOs (optional)
- Up to 32 timing events per GPO
- Simple PC parallel port connection
- Automatically log all actions
- All settings automatically saved
- Full access control including password
- Connection to PC required only for switching devices on and off



PC-Controlled MkII

Design by Trent Jackson

This is the safest way to control 240VAC appliances from your PC's parallel port.

We have used the parallel port as it is still the most cost-effective way to control external devices. Using a 3-bit address, up to 16 240VAC mains outlets can be controlled from your computer using Windows 95, 98, 2000, XP or ME.

You can create up to 32 different timing events and save them to a directory for later recall. The software will actually reload the last used settings the next time that you run the program.

Applications can range from lighting and security to full-on home automation.

The software includes a password and user access level facility which means that the project could function as a low cost security switch.

Interestingly, you don't need to keep your PC turned on permanently to control the project since the circuit uses latches to retain the switch settings until they are changed by the computer.

The PC-controlled Mains switch is housed in a plastic box with two flush-mounted 240VAC 3-pin sockets.

There are four indicator LEDs under a Perspex panel. Two of those LEDs indicate when one or both of the outputs are switched while the third indicates that power is present in the PC switch itself. The fourth LED indicates successful connection to your PC.

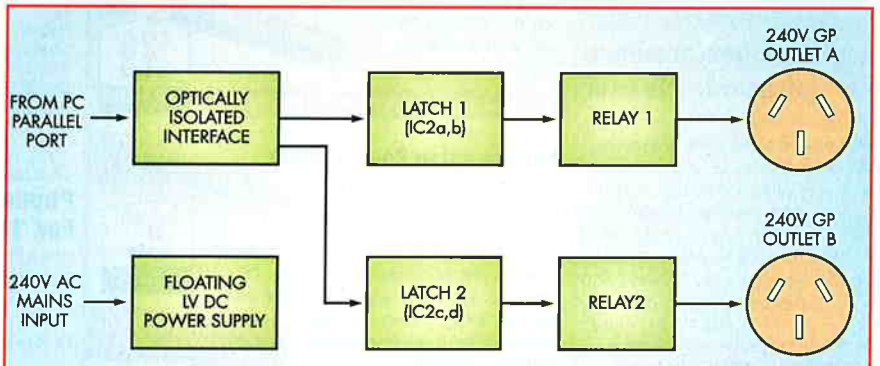


Fig.1: the circuit uses optocouplers for safe islation from 240VAC.

Block diagram

Fig.1 shows the block diagram of the circuit. Eight optoisolators are used to connect the PC's par-

Mains Switch

allel printer port to the interface which decodes the port addressing and drives two latches, one for each relay. The relays then switch power the 240VAC sockets.

The circuit

All told, it is a simple concept although the full circuit in Fig.2 (overleaf) looks a lot more complex. So let's break it down into bite-size chunks.

On the lefthand side of the circuit is the 8-bit parallel port and each of the eight data lines is fed to its own optoisolator. Data lines D5, D6 & D7 are coupled via optos to IC1, a 74HC138 1 of 8 decoder which works in conjunction with an 8-way DIP switch.

IC1 decodes the 3-bit binary code from the parallel port and pulls one of its eight outputs low as result. The desired output is selected by switching one of the 8-way DIP switches on. The DIP switch outputs are connected via eight diodes to the commoned emitters of optoisolators 5, 6, 7 & 8.

WARNING

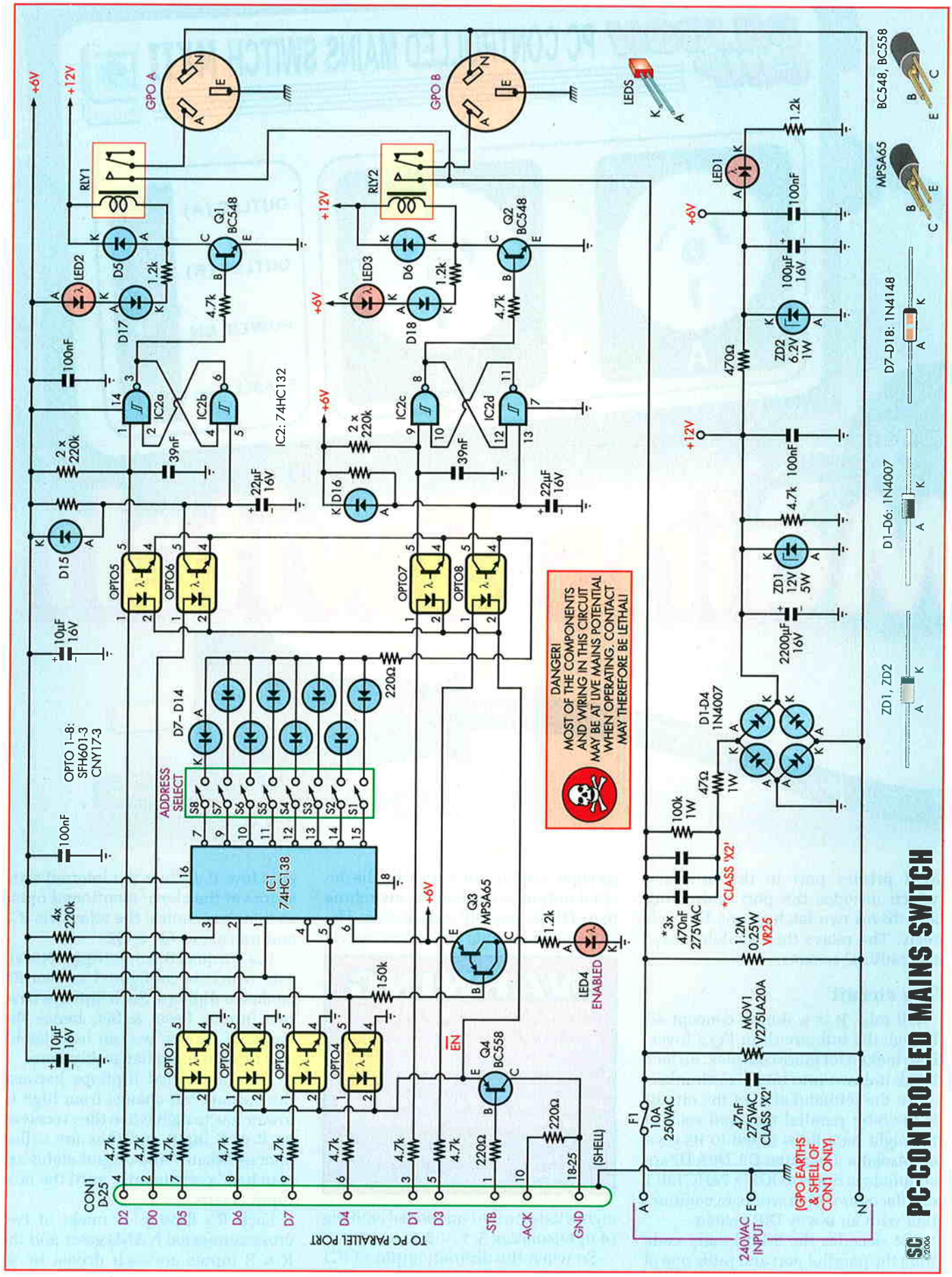
This is a mains-powered device and many sections of the circuit operate at full mains potential and are therefore dangerous. This project should only be constructed by those experienced in mains-powered projects and the testing procedure detailed here must be fully complied with before connection to a PC.

So when the desired output of IC1 goes low, it enables the internal transistors of the above-mentioned optos so that they control the relays via IC2 and transistors Q1 & Q2.

IC2 is a quad Schmitt trigger NAND gate which is configured as two RS latches or flipflops. Such flipflops have two inputs, Reset & Set; hence the name RS. Notice we can use "latch" and flipflop interchangeably here.

They are called flipflops because the outputs can change from high to low or low to high when they received an R or S input and they are called latches because the output states are "latched" permanently until the next input occurs.

Each RS flipflop is made of two cross-connected NAND gates and the R & S inputs are each driven by an


PC-CONTROLLED MAINS SWITCH
DANGER! MOST OF THE COMPONENTS AND WIRING IN THIS CIRCUIT MAY BE AT LIVE MAINS POTENTIAL WHEN OPERATING. CONTACT MAY THEREFORE BE LETHAL!
IC1 74HC138
IC2: 74HC132
OPTO 1–8: SFH601-3 CNY17-3
D1–D4 1N4007
D1–D6: 1N4007
D7–D18: 1N4148
ZD1, ZD2
BC548, BC558
MPSA65
ADDRESS SELECT
TO PC PARALLEL PORT
240VAC INPUT
(GPO EARTHS & SHELL OF CON1 ONLY)
*CLASS 'X2'
GPO A
GPO B
LEDS
RLY1
RLY2
MOV1 V275LA20A
F1 10A 250VAC
VR25
ENABLED

optoisolator – nice and simple.

But while RS flipflops are simple they do need to be reset each time the power is turned on. This is achieved with diodes D15 & D16 and the associated 22µF capacitors and 220kΩ resistors.

These work as follows: when power is applied, the 22µF capacitors at pin 5 & 13 (reset inputs) of IC2 are at 0V while pins 1 & 9 (set inputs) with just 39pF present can immediately go high. This sets pins 3 & 8 low and keeps transistors Q1 & Q2 off so the relays are unenergised. Subsequently, the 22µF capacitors charge up to 6V via the 220kΩ and so all the inputs of the latches are under the control of the optoisolators. When power is turned off, diodes D15 & D16 discharge the 22µF capacitors via the collapsed 6V rail.

The use of these latches along with addressing ensures that if multiple units are connected to the one PC, the units can retain their switch states.

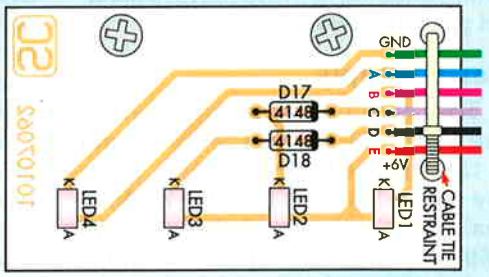
Along with having three optos to control the addressing, four to control the set and reset lines of the two latches, an eighth opto is used to enable IC1. This in turn allows us to use a LED that indicates that the unit is indeed connected to the PC. When the unit is enabled, transistor Q3 becomes forward biased and in turn switches on LED4.

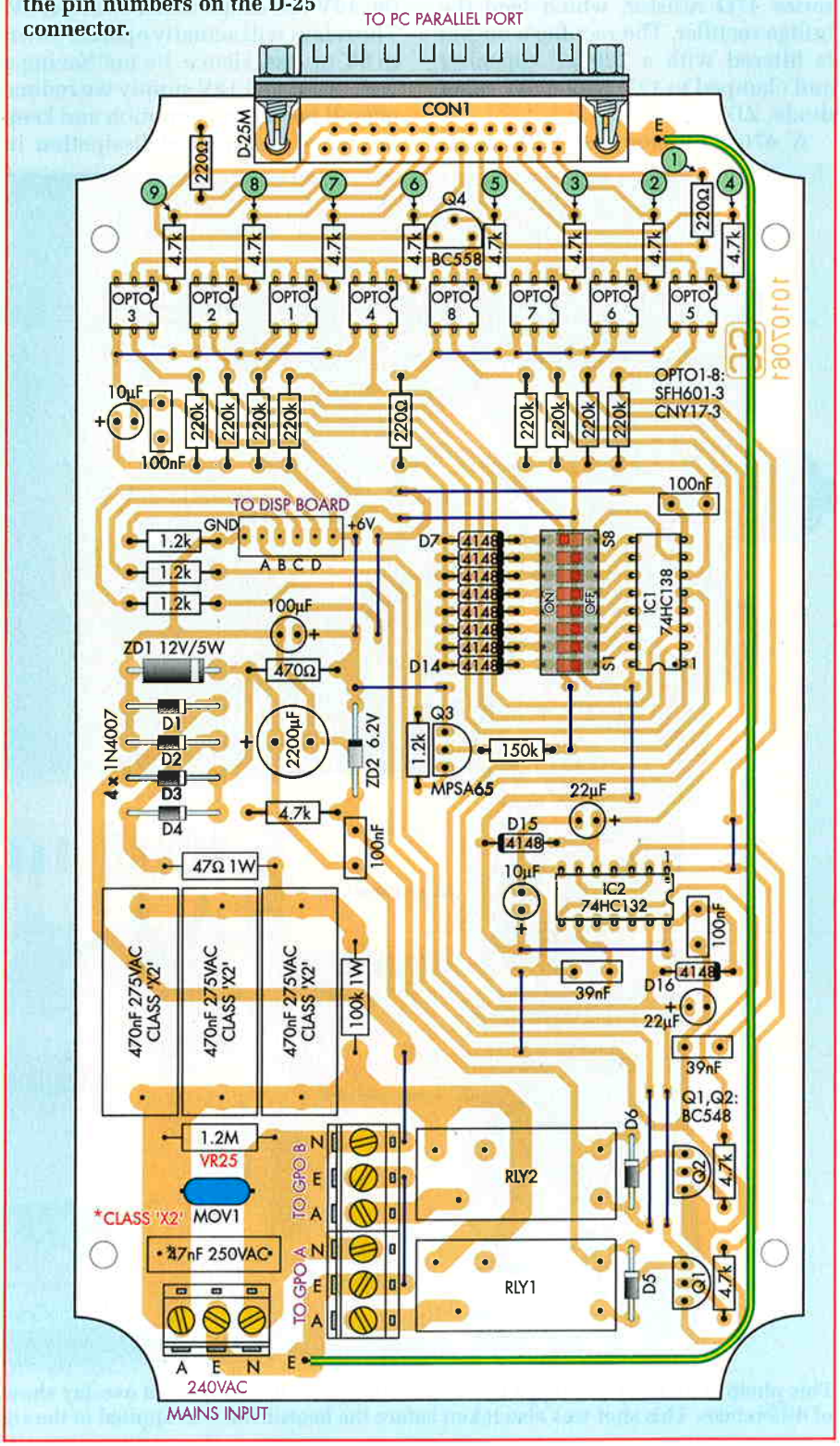
No ground connection

Interestingly, the cathodes of all eight optos are not connected directly to the port's ground return (pins 18-25). Instead, they are switched to ground via transistor Q4, itself controlled by the port's strobe line (pin 1). Why is this so? The simple answer is that when a PC first boots up all of the lines on the printer port except for the strobe get toggled. If the optos all had their negative returns connected directly to the ground of the PC, the result would that the 240VAC outputs would be erratically switched on and each time you turn on your PC. So, by controlling the return path with Q4 and the strobe signal, the optos are only enabled when commanded by the software.

Finally notice the 220Ω resistor connected between pins 10 & 18-25 on the parallel port D25 connector. This resistor tells the software that a unit is connected, so the software can then initialise and perform accordingly. The software is the real heart of this project while the electronics is just a

On the facing page is Fig.2, the complete circuit diagram.Figs 3 (right) and 4 (below) show the component overlays for the display board and main board, respectively. Not shown on the overlay below is the heatshrink safety covering over the opto couplers. The numbers in green circles (below) correspond to the pin numbers on the D-25 connector.





dumb interface between the PC's parallel port and the two relays.

Power supply

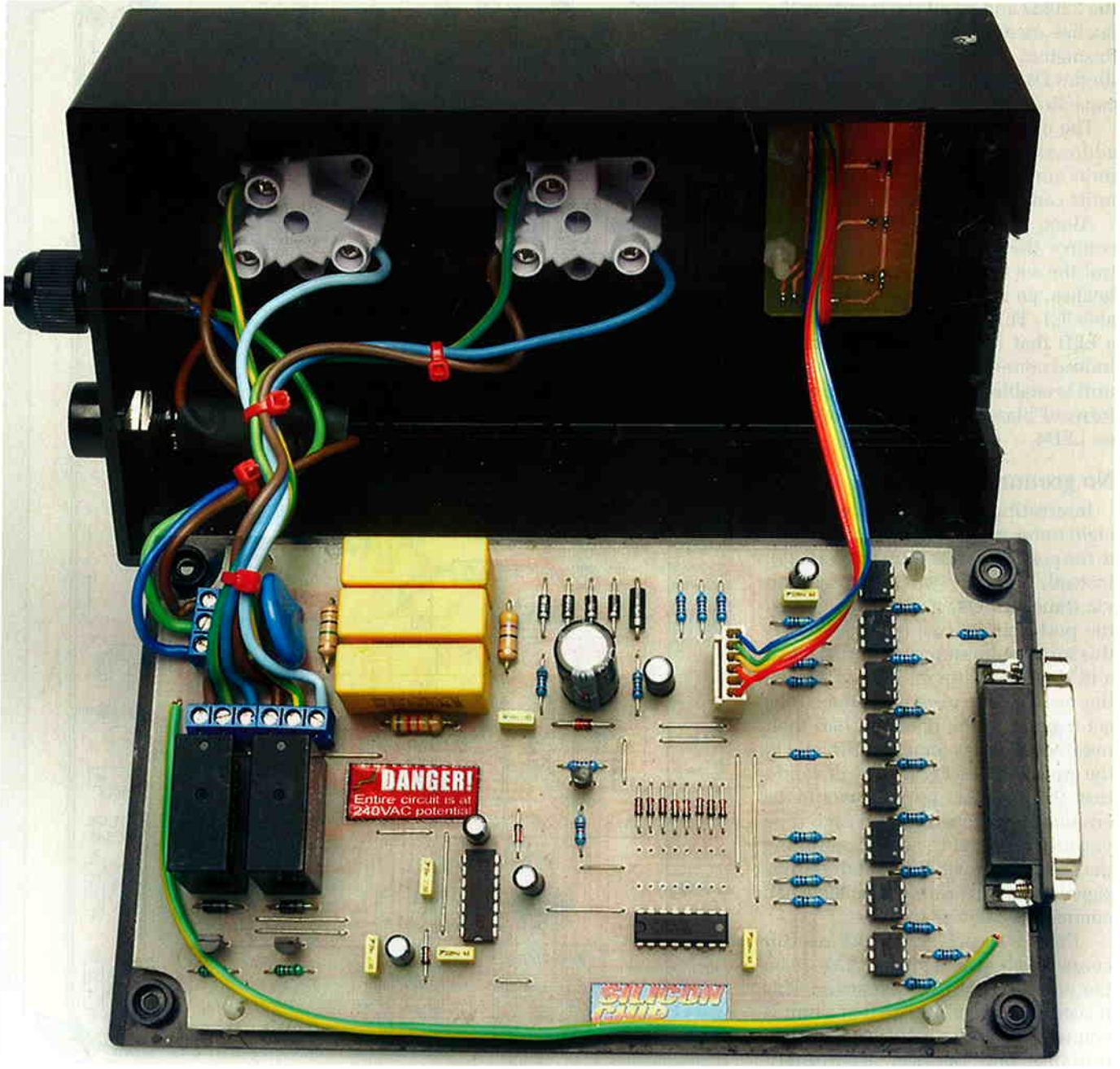
Two supply rails are required for the circuit. 6V for the CMOS ICs and a 12V rail for the two relays. These are derived directly from the 240VAC mains via a bank of three 470nF 250VAC class 'X2'capacitors and a series 47Ω resistor, which feed the bridge rectifier. The rectifier's output is filtered with a 2200µF capacitor and clamped to 12V with a 5W zener diode, ZD1.

A 470Ω resistor and 6.2V zener diode, ZD2, are used to derive the 6V rail from the 12V rail. This 6V rail actually drops down to about 5V or so once under full load with both relays active and all of the LEDs on.

Note that the 12V zener diode does not dissipate 5W. In practice, it dissipates 1W or less under the worst case conditions which apply when both relays are off. With both relays on, the 12V rail drops down to about 9V. The relays will actually operate down to 6V or less. Hence, by not having a well-regulated 12V supply we reduce overall power consumption and keep the worst-case power dissipation in ZD1 to a comfortable figure (ie, below 1W or thereabouts).

Directly connected across the 240VAC mains line after the 10A fuse is a 47nF c apacitor and a varistor. The 47nF capacitor provides a small degree of filtering for the mains supply while the varistor protects the entire circuit against voltage spikes of more than 275VAC. A 1.2MΩ resistor connected across the 240VAC mains input and a 100kΩ resistor in parallel with the three 470nF capacitors ensures that when power is disconnected the capacitors are discharged.

Note that by virtue of the bridge



This photo of an early prototype has minor changes to the component overlay shown in Figs. 4 & 5 – follow the overlay in case of differences. This shot was also taken before the heatshrink was applied to the right side of the PC board and cable.

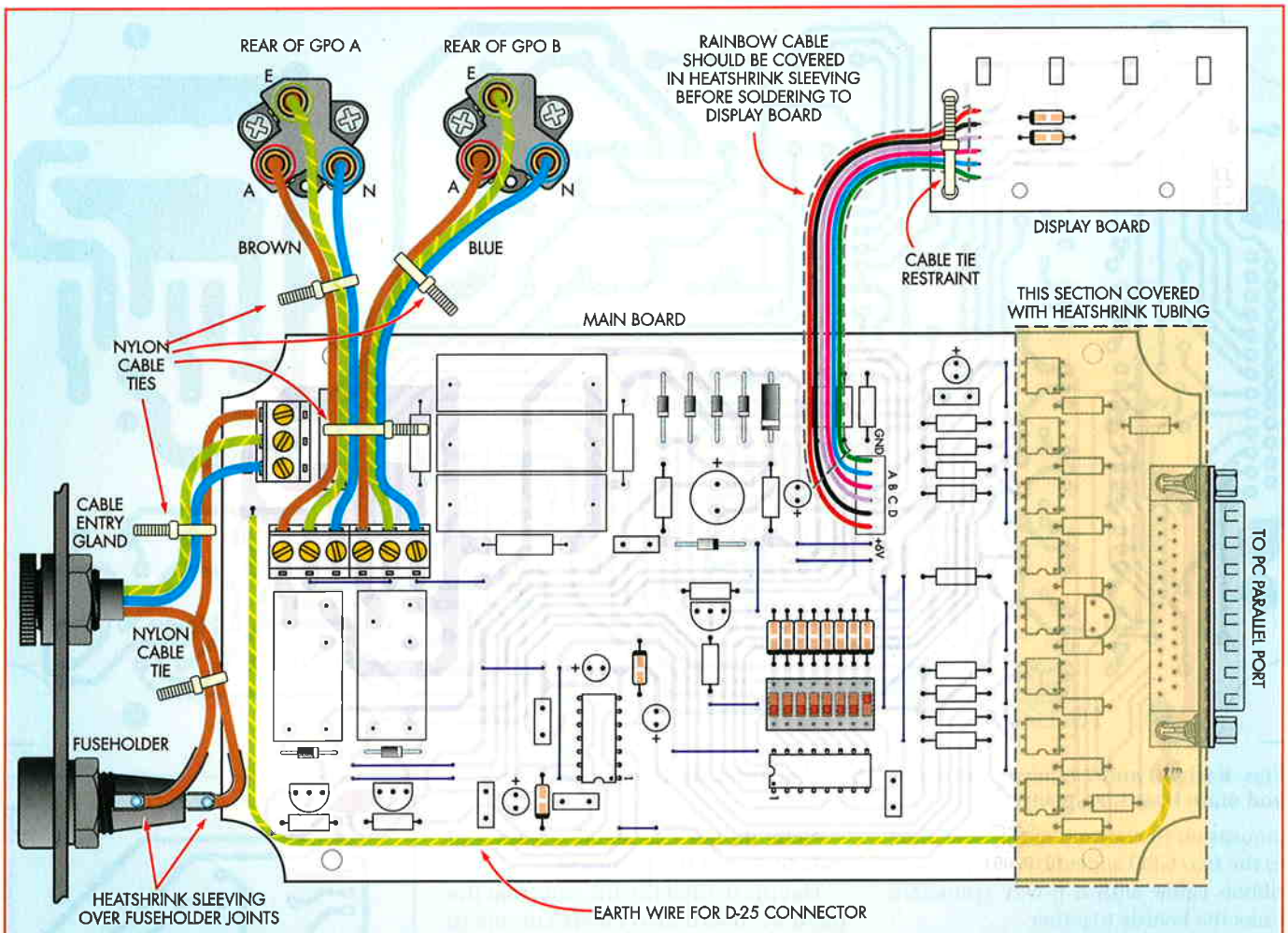
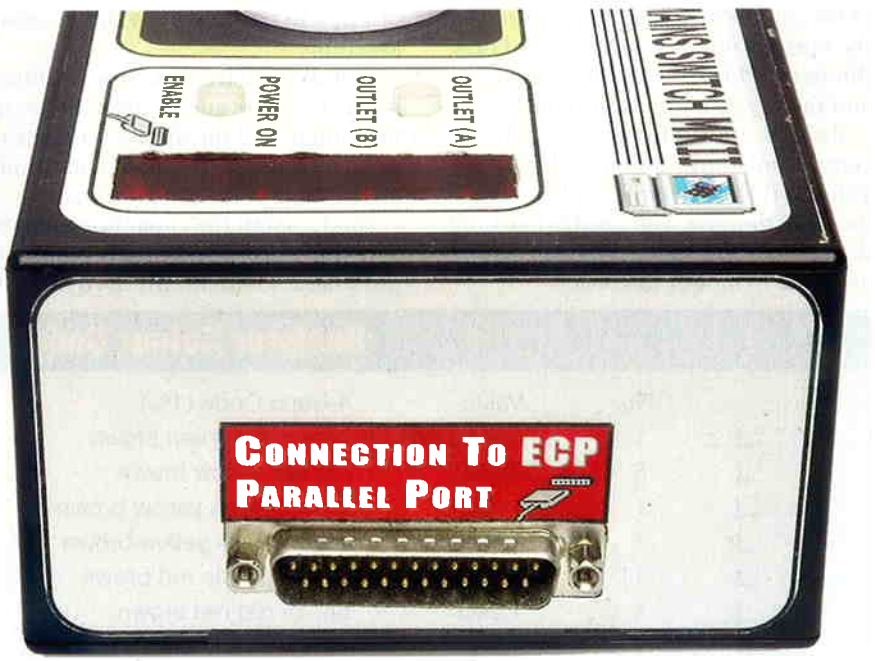


Fig. 5: follow this diagram carefully when completing the wiring. Remember that significant portions of the circuit are at mains potential so *never* work on the project when plugged in and/or without the cover screwed into place.

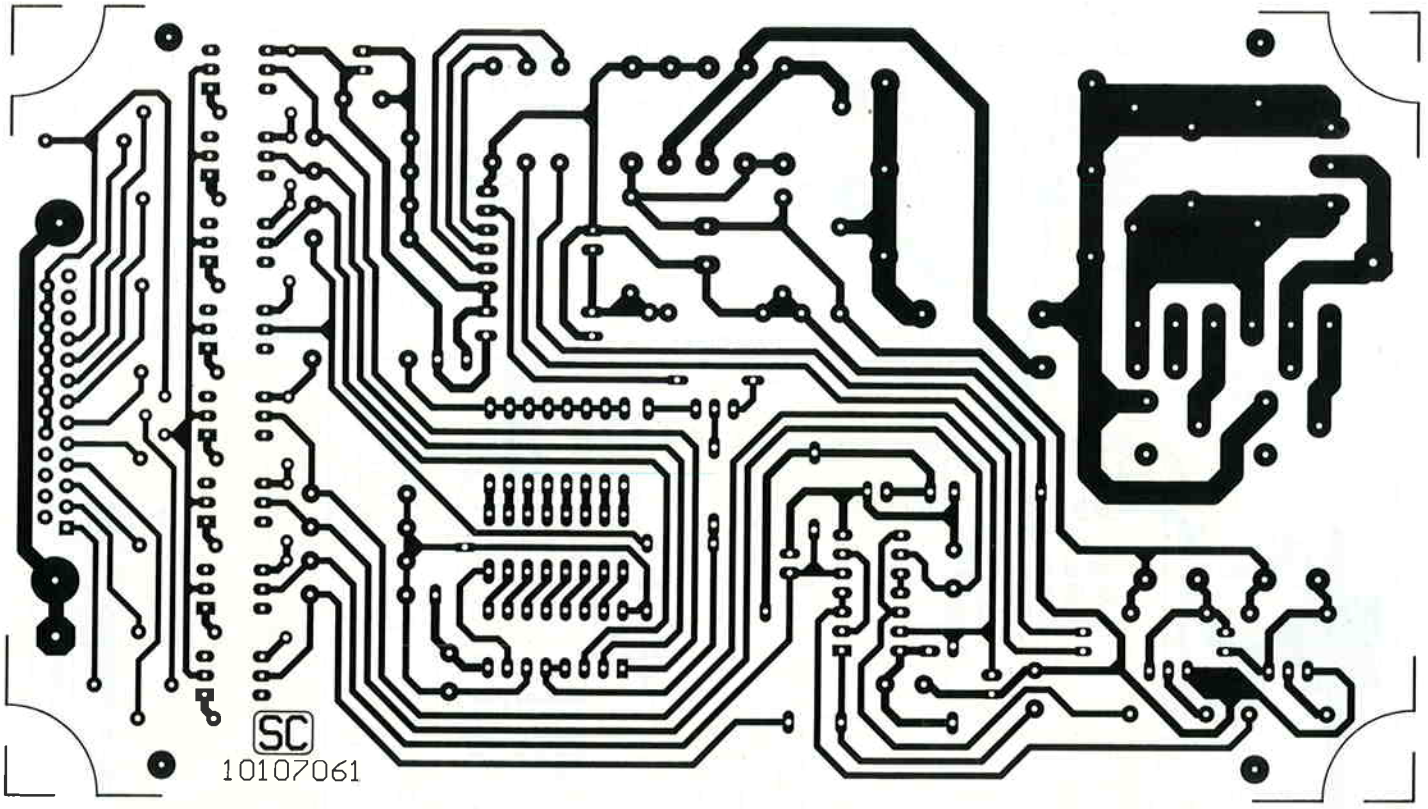
rectifier (diodes D1-D4), the 12V and 6V supply rails are tied close to the Neutral line of the 240VAC mains, so provided you connect to a correctly wired GPO (240VAC socket), most of the circuit is nominally at low potential and quite safe. However, you cannot always depend on this and if your GPO or power cord has Active & Neutral wires transposed, **most of the circuit will be at the full 240VAC potential and definitely not safe to touch.** That is why we have incorporated the eight high-voltage optoisolators into the circuit.

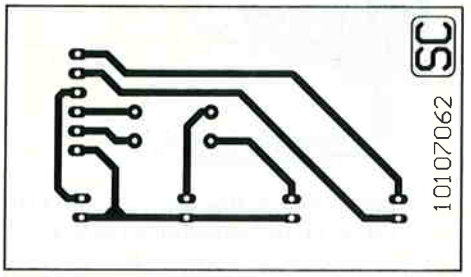
Construction

The PC-controlled Mains Switch is housed in a plastic case measuring 196 x 112 x 62mm. The lid is used as the base of the case and has the main PC board mounted on it. The main PC board measures 185 x 104mm and is coded 10107061. Also there is a small PC board to mount the four LEDs. It



Computer connection is via a standard 25-pin D connector, which emerges from a cutout in the end of the case, This connector is internally earthed via a length of earth wire back to the mains earth on the PC board.





Figs. 6 (right) and 7 (above): full-size PC board artwork for the display board and main board, respectively.

mounts on the bottom of the case, next to the two GPO sockets. A short 6-way ribbon cable with a 6-way connector links the boards together.

A 25-pin D socket for the parallel port interface is mounted at one end of the main PC board. A cutout needs to made at one end of the case for this socket. Other cutouts in the case are required for the Perspex window for the four LEDs, the two GPO sockets, the mains fuse and the mains cord cable gland.

Before you start assembly of components onto the main PC board, you should use it as a template to drill the lid of the case. You need to mark out the positions of the four Nylon screws and nuts to mount the board.

Note: do not use metal screws and nuts to mount the PC board.

Having drilled the lid, note that the main PC board also needs cutouts to provide clearance for the four corner pillars in the case. If your board does not have these, you will need to cut and file them. Then use the diagram of Fig.3 to guide you in the PC board assembly.

Install the wire links first, followed by the resistors and diodes. Make sure that you install the diodes with correct polarity and ensure that zener diodes are in their correct positions.

Next, install the capacitors, making sure that the electrolytics are correctly polarised. Then mount the 8-way DIP switch; note the orientation shown on Fig.3 and in the photos.

Then you can mount the two relays, the varistor, the integrated circuits and the four transistors.

Finally, install the 25-pin D socket, the 6-way polarised header connector for the LED board and the three 3-way insulated terminal blocks for the 240VAC connections. Do not make

Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	1.2MΩ (VR25)	brown red green brown	brown red black yellow brown
8	220kΩ	red red yellow brown	red red black orange brown
1	150kΩ	brown green yellow brown	brown greenblack orange brown
1	100kΩ (1W)	brown black yellow brown	brown black black orange brown
11	4.7kΩ	yellow purple red brown	yellow purple black red brown
4	1.2kΩ	brown red red brown	brown red black red brown
1	470Ω	yellow purple brown brown	yellow purple black black brown
3	220Ω	red red brown brown	red red black black brown
1	47Ω (1W)	yellow purple brown brown	yellow purple black black brown

any connections to 240VAC power at this stage.

Next, assemble the LED board, as shown in Fig.4. This board measures 60 x 35mm and is coded 10107062. Four rectangular LEDs and two diodes need to be mounted as well as the 200mm long 6-way ribbon cable which is clamped to the board with a small cable tie. The ribbon cable is terminated in a 6-way plug to match the polarising header connector on the main board. Note that the ribbon cable should be sheathed in heatshrink sleeving, for extra safety.

Testing with a DC supply

When both boards are complete, they can be connected together via the ribbon cable but do not connect 240VAC to the main board.

Instead, it can be safely powered from a variable DC supply capable of delivering between 14V and 16V or thereabouts so you can perform the tests needed without risk.

Connect the positive lead to the junction of the three 470nF capacitors and the 47Ω resistor and connect the negative lead to the Neutral supply line. This connection will let current flow via the bridge rectifier to the 12V zener diode, ZD1.

Apply power and you should be able to measure 12V across ZD1 and 6.2V (or close to it) across ZD2 and between pins 16 & 8 of IC1 and pins 14 & 7 of IC2.

Assuming that all is as it should be you can now test out the logic on the unit by firstly placing DIP switch 8 in its ON position, with all the rest off. Then connect a wire between 0V and pin 1 of the 25-pin D connector.

Now we are going to enable the unit by connecting a wire between the +6V rail and pin 6 of of the 25-pin D connector. This effectively enables the unit and LED4 should come on.

If we briefly connect another wire between +6V and pin 4, this should cause relay 1 to switch on; you should be able to hear the click. Do the same with pin 3 and relay 2 should come on.

To reset the flipflops and switch off the relays, briefly make a connection between +6V and pin 2 to de-energise relay 1 and between +6V and pin 5 to de-energise relay 2. You should hear both relays switch off.

If you haven't managed to get this far and hear the relays click on & off,

Parts List – PC-Controlled Mains Switch

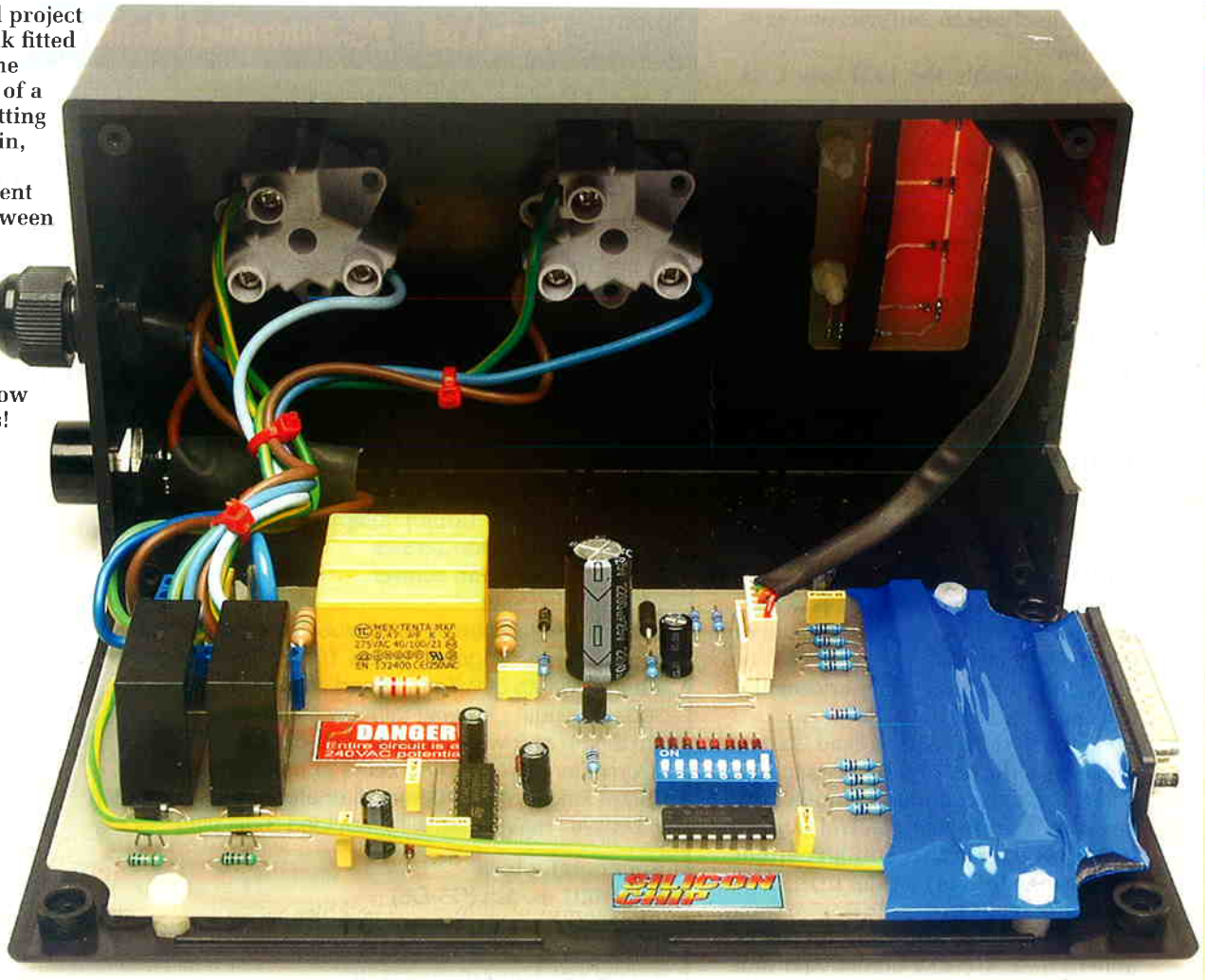
1 main PC board coded 10107061
1 display PC board coded 10107062
1 2mm thick red perspex "window", 55 x 14mm
2 DPST PC-mount 12V relays with 10A/250VAC contacts (RLY1, RLY2)
1 V275LA20A varistor (MOV1) (Altronics R 4408, Jaycar RN-3400)
1 D-25 PC-mount male connector (CON1)
1 D-25 male connector with backshell
1 D-25 female connector with backshell
2 panel-mount GPO sockets
3 3-way 10A/250VAC terminal blocks
1 3AG panel-mount fuse holder with 10A/250VAC slow-blow fuse
1 waterproof cable gland to suit 240VAC mains lead
2 14-pin IC sockets
1 8-way DIP switch (S1-S8)
1 'UB2' size jiffy box
2 M3 x 10mm (or 12mm) untapped Nylon spacers
4 M3 x 12mm Nylon screws
2 M3 x 20mm Nylon screws
14 M3 Nylon nuts
600mm length of brown and blue 10A/250VAC cable for mains wiring
850mm length of green/yellow 10A/250VAC cable for mains wiring
400mm length of 0.7mm tinned copper wire for links
300mm length of 6-way rainbow cable
2m length of 9-way shielded data cable
220mm length of 10mm diameter heatshrink tubing
70mm length of 85-100mm diameter heatshrink tubing
1 240VAC mains lead with moulded 3-pin plug

Semiconductors
6 1N4007 diodes (D1-D6)
12 1N4148 small signal diodes (D7- D18)
1 12V 5W zener diode (ZD1)
1 6.2V 1W zener diode (ZD2)
4 5 x 2mm rectangular red LEDs (LED1-LED4)
8 SFH601-3 or CNY17-3 optocouplers (OPTO1-OPTO8) (***do not substitute***)
2 BC548 NPN transistors (Q1, Q2)
1 BC558 PNP transistor (Q4)
1 MPSA65 PNP Darlington transistor (Q3) (DSE Z-2088)
1 74HC138 1-of-8 decoder (IC1)
1 74HC132 quad NAND gate (IC2)

Capacitors
1 2200µF 16V PC electrolytic
1 100µF 16V PC electrolytic
2 22µF 16V PC electrolytic
2 10µF 16V PC electrolytic
4 100nF 50V MKT polyester (code 104, 100n or 0.1)
2 39nF 50V MKT polyester (code 393, 39n or 0.39)
3 470nF 275VAC class 'X2' polyester (code 474, 470n or 0.47; X2)
1 47nF 275VAC class 'X2' polyester (code 473, 47n or 0.047; X2)

Resistors (0.25W 5%)
8 220kΩ 1 150kΩ 11 4.7kΩ 4 1.2kΩ 1 470Ω 3 220Ω
1 100kΩ 1W 1 47Ω 1W
1 1.2MΩ VR25 (***do not substitute***) (Farnell 947-7152)

Note: the SFH601-3 optocoupler is available from Wiltronics Research, phone 1800 067 674 or see **www.wiltronics.com.au**. The alternate CNY17-3 is available from Farnell (stock no. 359-8380), phone 1300 361 005 or see **www.farnellinone.com.au**. Large bore heatshrink is available from **www.batterypower.com.au** (choose the 125mm flat width product) or your local electrical wholesaler.



The completed project with heatshrink fitted for safety (in the unlikely event of a mains lead "letting go"). Once again, there are some minor component differences between this and the overlay diagrams of Figs. 4&5 shown earlier. If in any doubt, follow those diagrams!

don't go any further with the project until you do. Get some assistance if need be.

The case

When the PC board is fully checked out, the 240VAC mains wiring for the unit can be done and the rest of the assembly completed. Before proceeding though, you will need to do some more work on the case to provide the cutouts for the 25-pin D socket (in the end of the case), the two GPO sockets, the window for the LED board and holes in the other endo the case for the mains cable gland and the fuseholder.

The LED window needs to be 55 x 14mm while the holes for the cable gland and fuseholder are 12.5mm in diameter.

Fig.5 shows the complete wiring diagram. All the mains wiring must be run in 250VAC-rated wire and it should be tied in place with cable ties as shown. Don't forget to run the green/yellow earth wire on the main PC board. This earths the 25-pin D socket.

When all the wiring is complete, you need to fit pieces of heatshrink, to prevent the admittedly unlikely event of a mains wire coming loose and touching the PC side of the optos. The photo above shows the completed project, with both pieces of heatshrink fitted.

First, a sleeve of heatshrink is fitted over the entire socket end of the board. After sliding the heatshrink over the D-socket and PC board (back as far as the row of resistors adjacent to the opto isolators) it must of course be shrunk into position.

A hair dryer on highest heat should be able to do this but a heat gun will be better (but be careful with those – they can easily melt plastic or damage other components!).

After fitting, a small amount of minor surgery will be needed – the corners have to be trimmed out with a sharp knife or blade to match the PC board profile underneath, allowing the PC board to fit into the case.

Also, two holes need to be punched or drilled through the heatshrink to allow the mounting screws to pass through.

A much thinner length of heatshrink should be used to shroud the ribbon cable between the main and display PC boards.

Reality check

You should make a few last checks before you connect the PC switch to your computer's parallel port and power up. First, do a continuity test between Active & Neutral on the power lead with your DMM: if you get a reading of about 1.2MΩ, you've done well.

Again with your DMM, make doubly sure that the Earth pin of the plug is connected through to the shell of the D25 socket. Finally, make sure there is no circuit between Active & Earth and Neutral & Earth.

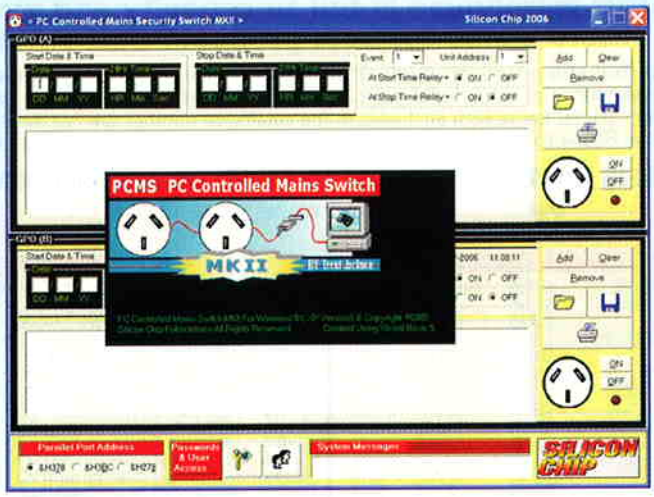
If, and only if, all those tests are satisfactory, proceed with loading the software and moving on to the setting up of your PC-controlled switch.

Driving the Controller

First thing, load the setup software (imaginatively named setup.exe; downloadable in a zip file from siliconchip.com.au).

Follow the install prompts and get the main interface program (shown at left/right/indifferent) on the screen.

Assuming that you have done all the testing as detailed earlier and given the board a final sanity check, connect the unit to your PC's parallel port via a suitable cable (ie, straight through, pin to pin) and power up.



This is the screen which should greet you once the software is loaded and run . . .

By the way, you can dummy-run through the software setup without a unit connected, just to see what does what.

Click on GPO A's "manual on" button – it's at the bottom right of GPOA's panel. Immediately you should see a couple of changes: the "LED" image below the switches changes from black to red, while a lightning bolt symbol appears across GPO A - both saying that GPO A is on.

You should also see a system message appear in the box at the base of the screen saying, for example, "GPOA Switched ON @ 06:06:06 06-06-2006" Devilishly clever, what?

Now try the auto part: check your exact system time (double click on the time at far bottom right of the PC screen). You might like to correct the time now if it is out.

Select a time which is, say, a minute from the current time and enter it, in 24 hour format, into either GPOA or GPOB along with the date in DD/MM/YY format, into the "Start Date & Time" panel.

Alongside this, enter a stop date and time in similar manner – make it, say, a minute later. Click the "ADD" button and all these details will appear in the appropriate GPO's window.

When your PC's clock changes to the selected minute, you will again see the red "LED" and lightning bolt, showing the outlet is turned on – and naturally the reverse when it turns off.

Password protection

Unless your PC, the Controller and all controlled devices are locked away, password protection would seem to be a bit of overkill (what's to stop someone pulling a plug, or connecting to another [uncontrolled] outlet?).

Still, the option is there, at the bottom of the screen, should you ever need it. The "keys" symbol allows you to log on and off, while the "heads" symbol allows you to set up access control.

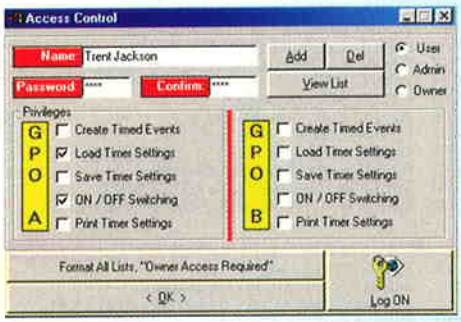
Parallel port and address

The software gives you the option of three different addresses for the parallel port. The most usual port address for LPT1 is H378, while LPT2 is usually H278.

The H3BC base address was originally introduced used for parallel ports on early video cards. This address then disappeared for a while, when parallel ports were later removed from video cards. They've now reappeared somewhat as an option for parallel ports integrated onto motherboards, upon which their configuration can be changed using BIOS.

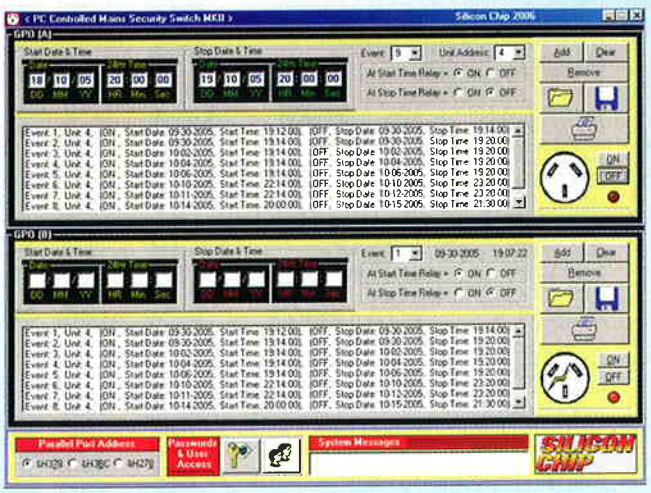
One small wrinkle: the PC Controlled Mains Switch requires the use of an "Enhanced Capabilities" (ECP)-enabled parallel port and at least originally, H3BC did not support ECP. If you have problems with your controller, check that you have the port set up for ECP and it is a valid address.

If the unit's address (set by the DIP switches) is still set to 8, select unit 8 on the software, click on the "ON" button for GPO A and the relay for GPO A should click on and the associated LED should light.



Now do the same for GPO B: click on the "ON" button and the other relay should click on and the LED for GPO B should light. Now try selecting a few different addresses on the DIP switch and ensure that all of the logic circuitry is working as it should be.

This done, you can finalise the settings on the software by setting up the access control part, assuming that this is required. **SC**



WINTER CLEARANCE SALE

Over 10% - 75%** OFF ALL LISTED ITEMS

HELP!!! **Our warehouse is full to capacity and we desperately need more space for new products that will be arriving soon!**

Listed below are some discontinued (but still good) products and some other items that we have too much stock of, at ridiculous prices. You can get most of the items below at your local Jaycar Store or from our Techstore - via the internet or mail order but we cannot guarantee this! (Note: Items with an * next to the catalogue number are not available through Techstore!)
Please ring your local Jaycar Store to check stock. At these prices we won't be able to ship from store to store!

ITEMS WILL SELL FAST & STOCK IS LIMITED - ACT NOW TO AVOID DISAPPOINTMENT. SORRY - NO RAINCHECKS

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MB-3501	BATTERY CHARGER SOLAR TO SUIT CAR 15V 120MA	$49.95	$29.95	$20.00
MB-3507	BATTERY CHARGER NI-MH/NI-CD 240V & 12V	$59.95	$29.95	$30.00
MB-3518	BATTERY CHARGER SLA 2V/6V/12V 600MA WITH CLIPS	$42.95	$29.95	$13.00
MB-3528	BATTERY CHARGER SLA 12V 4A AUTO	$99.00	$69.95	$29.05
MB-3530	BATTERY CHARGER NI-MH/NI-CD 240V 4AA LED	$14.95	$8.95	$6.00
MB-3532	BATTERY CHARGER NI-MH/NI-CD 240V WITH BATTS	$19.95	$12.95	$7.00
MB-3537	BATTERY CHARGER NI-MH/NI-CD 240V 4AA/AAA 1HR	$59.95	$49.95	$10.00
XC-4950	BATTERY CHARGER NI-MH/NI-CD 4AA/AAA USB CON	$24.95	$12.95	$12.00
PH-9293*	BATTERY HOLDER 3 x AA SUIT TORCHES ST-3334/38	$2.95	$1.00	$1.95
SB-1643*	BATTERY PHONE NI-MH 3.6V 600MAH [AUDIOLINE]	$26.95	$9.95	$17.00
SB-1647*	BATTERY PHONE NI-MH 3.6V 650MAH [AUDIOLINE]	$16.95	$7.95	$9.00
SB-1700	BATTERY NI-MH AA 1.2V 1650MAH NIPPLE	$3.95	$1.30	$2.65
SB-1702*	BATTERY NI-MH AA 1.2V 1650MAH TAG	$4.75	$1.50	$3.25
SB-1722*	BATTERY NI-MH AAA 1.2V 800MAH TAG	$3.78	$1.20	$2.58
SB-2340	BATTERY ZINC CHLORIDE AAA EXTRA HEAVY DUTY PK4	$3.20	$2.50	$0.70
SB-2341	BATTERY ZINC CHLORIDE AA EXTRA HEAVY DUTY PK4	$2.50	$2.00	$0.50
SB-2342	BATTERY ZINC CHLORIDE C EXTRA HEAVY DUTY PK2	$2.95	$2.25	$0.70
SB-2343	BATTERY ZINC CHLORIDE D EXTRA HEAVY DUTY PK2	$2.10	$1.55	$0.55
SB-2401	BATTERY LITHIUM 6V CRP2 CAMERA 35MM	$15.95	$7.50	$8.45
SB-2402	BATTERY LITHIUM 6V 2CR5 CAMERA 35MM	$15.95	$7.50	$8.45
SB-2404	BATTERY LITHIUM 3V CR2 CAMERA 35MM	$9.95	$4.00	$5.95
SB-2455*	BATTERY NI-MH AA 1.2V 1000MAH NIPPLE	$3.35	$1.50	$1.85
SB-2479*	BATTERY TELEPHONE NI-CD 3.6V 700MAH	$13.50	$6.35	$7.15
SL-2758*	FLUORO STARTER ELECTRONIC 10-40W 240VAC	$11.25	$7.50	$3.75
MS-4054	POWERBOARD 4 WAY FILTER, SURGE, TV WITH	$19.95	$14.95	$5.00
MP-3039*	PSU 12V/8V AC 1A BARGAIN	$9.95	$3.95	$6.00
MP-3073	PSU LAB 13.8VDC 5A REG BIND POST	$109.50	$69.00	$40.50
MP-3077	PSU LAB 13.8VDC 15A REG BIND POST	$189.50	$109.00	$80.50
MP-3084	PSU LAB 0-30VDC/3A +5VDC/3A +12VDC/500MA	$229.00	$169.00	$60.00
MP-3092	PSU LAB 0-40V 3A X2 DUAL TRACKING	$479.00	$379.00	$100.00
MS-6100	SWITCH RF 240V/1000W WITH REMOTE WHITE	$39.95	$19.95	$20.00
MS-6102	SWITCH RF TO SUIT MS-6100 240V/1000W WHITE	$29.95	$9.95	$20.00
ALARMS, SECURITY & SURVEILLANCE EQUIPMENT				
LA-5010	ALARM VISITOR CHIME	$33.50	$16.95	$16.55
LA-5191	ALARM CEILING WITH KEYCHAIN REMOTE	$29.95	$24.95	$5.00
LA-5312	CAMERA DUMMY METAL - CORNER MOUNT BRACKET	$29.95	$14.95	$15.00
QC-3285	CAMERA B&W PRO SERIES 36IR 24VAC W/PROOF	$249.00	$199.00	$50.00
QC-3287*	CAMERA COLOUR PRO 24VAC 350TVL 36IR W/PROOF	$399.00	$229.00	$170.00
QC-3294	CAMERA CCD COLOUR DOME VARI-FOCAL 420TVL	$229.00	$189.00	$40.00
QC-3296*	CAMERA DOME VARI-FOCAL F4.0-F9.0MM 480TVL	$329.00	$199.00	$130.00
QC-3307	CAMERA CCD COLOUR AUTO IRIS 480TVL PANASONIC	$299.00	$235.00	$64.00
QC-3309	CAMERA CCD COLOUR AUDIO SONY CHIP (NO LENS)	$249.00	$199.00	$50.00
QC-3310	CAMERA CCD B&W AUTO IRIS WITH AUDIO (NO LENS)	$99.00	$69.95	$29.05
QC-3314	CAMERA CCD COLOUR AUTO IRIS 420TVL + AUDIO	$199.00	$139.95	$59.05
QC-3338	CAMERA BRACKET CEILING MOUNT 30KG MAX	$49.50	$19.95	$29.55
QC-3395	CAMERA CMOS COLOUR PAN/TILT USB + REMOTE	$299.00	$199.00	$100.00
QC-3473	CAMERA CCD B&W MICRO PIN WITH AUDIO	$129.00	$99.00	$30.00
QC-3493	CAMERA CCD COLOUR PIN HOLE MICRO	$199.00	$159.00	$40.00
QC-3497	CAMERA CCD COLOUR DOME PAN/TILT WITH RC	$499.00	$429.00	$70.00
QC-3498	CAMERA CCD COLOUR DOME 480TVL PANASONIC	$299.00	$219.00	$80.00
QC-3500	CAMERA CCD COLOUR DOME 1/3IN PAN/TILT ZOOM	$799.00	$649.00	$150.00
LA-9010	CAR ALARM WITH REMOTE RADIO PAGER	$299.00	$199.00	$100.00
QV-3057	DVR CARD PCI 4CH 25F/SEC BNC INPUT	$239.00	$149.00	$90.00
QV-3059	DVR CARD PCI 8CH 50F/SEC BNC INPUT	$399.00	$259.00	$140.00
QV-3060	DVR STAND ALONE 4CHANNEL HDD 40GB	$1,995.00	$499.00	$1496.00
QV-3073	DVR 4CH MPEG2 WITH ETHERNET & HDD 120GB	$1,249.00	$829.00	$420.00
QV-3075	DVR 4CH MPEG4 WITH ETHERNET & HDD 250GB	$1,299.00	$1099.00	$200.00
LA-5474	KEYPAD ALARM & CONTROLLER - HOMENET	$59.95	$19.95	$40.00
LA-5023*	LENS PIR PET ALLEY 90DEG 12M TO SUIT LA-5020	$5.60	$1.75	$3.85
LA-5027*	LENS PIR PET ALLEY 90DEG 15M TO SUIT LA-5025	$5.60	$3.95	$1.65
LA-5031*	LENS PIR LONG RANGE 90DEG 30M TO SUIT LA-5030	$5.60	$3.95	$1.65
LA-5032	LENS PIR CURTAIN 90DEG 15M TO SUIT LA5025/LA5030	$5.60	$3.95	$1.65
QC-3342*	LENS CAMERA CS MOUNT 6MM ECON	$24.95	$5.50	$19.45
QC-3344*	LENS CAMERA CS MOUNT 8MM ECON	$24.95	$5.50	$19.45
QC-3437	SURVEILLANCE VIDEO AMP/DISTRIBUTOR 12VDC	$69.95	$49.95	$20.00
QC-3271*	WIRELESS CAMERA CMOS COLOUR 2.4GHZ QC-3270	$129.00	$49.95	$79.05
QC-3275*	WIRELESS CAMERA CMOS COLOUR 2.4GHZ QC-3274	$179.00	$79.95	$99.05
QC-3278*	WIRELESS RECEIVER MODULE 2.4GHZ 4CH & PSU	$129.00	$64.95	$64.05
QC-3560*	WIRELESS CAMERA CCD COLOUR 2.4GHZ 420TV	$229.00	$115.00	$114.00
QC-3580	WIRELESS RECEIVER CMOS COLOUR MINI 2.4GHZ	$199.00	$129.00	$70.00
QC-3581	WIRELESS CAMERA CMOS COLOUR 2.4GHZ (QC3580)	$129.00	$84.95	$44.05
QC-3582	WIRELESS CAMERA CMOS COLOUR 2.4GHZ (QC3580)	$129.00	$84.95	$44.05
QC-3583	WIRELESS CAMERA CMOS COLOUR 2.4GHZ (QC3580)	$129.00	$84.95	$44.05
QC-3590*	WIRELESS TRANSMITTER MODULE 2.4GHZ	$34.95	$17.95	$17.00
QC-3592*	WIRELESS RECEIVER MODULE 2.4GHZ	$49.95	$24.95	$25.00
QC-3598	WIRELESS TRANSMITTER MODULE 2.4GHZ	$34.95	$17.95	$17.00
QC-3599	WIRELESS RECEIVER MODULE 2.4GHZ	$49.95	$24.95	$25.00

Cat No	Description	Original RRP	Now	*Save on Orig RRP
COMPUTER ACCESSORIES				
YS-2832	CD SHREDDER BLACK 215X105X100MM	$39.95	$14.95	$25.00
XC-4900	CLEANING KIT MEMORY CARD COMPACT FLASH	$9.95	$7.95	$2.00
XC-4902	CLEANING KIT MEMORY CARD MMC/SD	$9.95	$7.95	$2.00
XC-4904	CLEANING KIT MEMORY CARD SMART MEDIA	$9.95	$7.95	$2.00
XC-5033	FAN GUARD 80MM PERSPEX WITH TRI-COLOUR LED	$12.95	$7.95	$5.00
XC-4814	HDTV DVB-T TV TUNER USB2 WITH ANTENNA	$249.95	$119.00	$130.95
XC-4819	HDTV TERRESTRIAL PCI CARD WITH REMOTE	$179.00	$99.00	$80.00
XC-4858	HDTV DVB-T & ANALOGUE PCI CARD WITH REMOTE	$199.00	$149.00	$50.00
XC-5135	KEYBOARD & MOUSE WIRELESS RF PS/2	$69.95	$39.95	$30.00
XC-4920	LABELLING KIT FOR CD/DVD W/SOFTWARE 12CM	$14.95	$9.95	$5.00
XC-4922	LABEL - CD/DVD PK50 12CM FOR KIT XC-4920	$9.95	$7.95	$2.00
QM-3790*	LCD VIRTUAL GLASSES WITH PSU & LEADS	$399.00	$199.00	$200.00
XC-4725	MEDIA - CDR 800MB/90MIN 48X	$1.35	$1.00	$0.35
XC-4730*	MEDIA - DVD-R 4GB7 SUIT STB W/CASE SGL	$1.95	$1.45	$0.50
XC-4742	MEDIA - DISK 3.5IN IMB 5COL PK25	$13.95	$7.95	$6.00
XC-4857	MEDIA IMAGE PLAYER 8-IN-1NTSC & PAL USB	$149.00	$69.95	$79.05
XC-4882	MULTIMEDIA 5.1 CH SURROUND SOUND CONVERTER	$29.95	$16.95	$13.00
XC-5034*	PC FAN BUZZER ALARM	$13.95	$6.95	$7.00
XC-5375	SIM CARD DATA PROTECTOR KEYRING	$19.95	$12.95	$7.00
XC-5140*	SIM CARD TWIN SWITCHER COVER FOR NOKIA 3310	$14.95	$4.95	$10.00
XC-5142*	SIM CARD TWIN SWITCHER COVER FOR NOKIA 8310	$14.95	$5.95	$9.00
XC-5161	SPEAKER USB MP3 FLASH PLAYER W/PSU	$89.95	$44.95	$45.00
XC-5167	SPEAKER MULTIMEDIA AMP PC 2.1 BLUE 13W PSU	$39.95	$29.95	$10.00
XC-5169	SPEAKER MULTIMEDIA AMP PC 5.1 55WRMS 240V	$89.95	$69.95	$20.00
XC-4812*	USB CARD READER	$69.00	$29.95	$39.05
ST-2809*	USB MINI-LIGHT AND MAGNIFIER W/STAND	$19.95	$9.95	$10.00
XC-4842*	USB PC LOCK W/LESS TX/RX BLACK	$69.95	$24.95	$45.00
XC-4880	USB RADIO X-TREME IR REMOTE CTRL	$79.95	$39.95	$40.00
QC-3224*	WEBCAM 5 IN 1 DIGITAL CAMERA, VIDEO, AUDIO/USB	$299.00	$149.00	$150.00
QC-3226	WEBCAM CMOS 1.3M PIXEL WITH STAND/USB	$49.00	$34.95	$14.05
COMPONENTS, METERS & TOOLS				
SF-1930*	FUSE BLADE MAXI 20A YELLOW	$1.95	$0.85	$1.10
SZ-2050*	FUSE HOLDER PANEL MOUNT 5AG ROUND	$5.65	$3.50	$2.15
SZ-2074	FUSE HOLDER GOLD 2GX4GIN 4X4G OUT	$44.95	$29.95	$15.00
SZ-2077	DISTRIBUTION BLOCK WITH VOLT DISPLAY GOLD	$49.95	$29.95	$20.00
QT-2300	GENERATOR SIGNAL AUDIO ANALOGUE 10HZ-1MHZ	$319.00	$219.00	$100.00
HH-8518	HEATSINK ALUMINIUM 10FIN 82X32MM	$2.70	$1.00	$1.70
QP-2273	METAL DETECTOR HAND HELD WITH AUDIO	$99.95	$59.95	$40.00
QP-5032	METER - VU ANALOGUE BLUE	$19.95	$5.95	$14.00
QM-1460	METER - DMM 4.5DIGIT RS232 BACKLIGHT & TEMP	$129.95	$99.95	$30.00
ZD-2022	SMD LED PINK [MOBILE NOKIA] PK6	$25.95	$6.95	$19.00
ST-0564*	SWITCH PCB MINI SPDT CENTRE OFF C&K	$1.20	$0.35	$0.85
ST-0565*	SWITCH TOGGLE MINI PCB DPDT	$3.95	$2.00	$1.95
QP-2214	TESTER POLARITY 3-15V INPUT AC/DC BLACK	$9.95	$7.95	$2.00
QP-2240	TESTER CIRCUIT 90-300VAC/DC NEON	$3.95	$2.95	$1.00
QP-2264	TESTER SPARK PLUG PEN TYPE	$5.95	$4.95	$1.00
QP-2276	TESTER NON CONTACT VOLTAGE WITH TORCH	$19.95	$14.95	$5.00
QP-2278	TESTER DETECTOR VOLTAGE KEYCHAIN BLACK	$9.95	$7.95	$2.00
QP-2284	TESTER DETECTOR STUD KEYRING	$8.95	$6.50	$2.45
QP-2290	TESTER VDV MULTIMEDIA IDEAL GREY	$199.00	$149.00	$50.00
QM-7229	THERMOMETER DIG FLEXIBLE PROBE WATERPROOF	$19.95	$11.95	$8.00
QM-7255	TOOL - STETHOSCOPE NURSE SILVER	$13.25	$9.95	$3.30
ST-3113	TOOL - LASER LEVEL BAR BEAM WITH TAPE MEASURE	$39.95	$14.95	$25.00
TD-2033	TOOL - SCREWDRIVER RATCHET ADJ. SUPERTORQUE	$13.95	$8.95	$5.00
TD-2034	TOOL - BIT SET TORX TAMPER PROOF 7PCE	$8.95	$3.95	$5.00
TD-2044	TOOL - DRIVER SET L-TYPE WITH BITS 11PCE	$10.95	$6.40	$4.55
TD-2046	TOOL - SCREWDRIVER TEST NEON 125-250VAC	$2.99	$1.45	$1.54
TD-2464*	TOOL - DRILL SET SUPERTOOL WITH BITS, CASE & PSU	$69.95	$39.95	$30.00
TH-1822	TOOL - STRIPPER & 7-IN-1 SCREWDRIVER	$19.95	$12.95	$7.00
TH-1876	TOOL - CONNECTOR F (RG6)	$9.95	$7.50	$2.45
TH-1895	TOOL - CUTTER CABLE 200MM 30MM COPPER MAX	$24.95	$14.95	$10.00
TH-1902	TOOL- KNIFE POCKET WITH REMOVABLE LED TORCH	$9.95	$5.95	$4.00
TH-2316	TOOL- WRENCH ADJUST. 12IN STAINLESS STEEL	$29.95	$9.95	$20.00
TH-2322*	TOOL- PLIERS SLIPJOINT 10IN STAINLESS STEEL	$22.95	$9.95	$13.00
TH-2324	TOOL- PLIERS SLIPJOINT 12IN STAINLESS STEEL	$29.95	$9.95	$20.00
TL-4000	TOOL- LATHE MICRO 240VAC	$899.00	$649.00	$250.00
AUDIO & VIDEO PRODUCTS				
LT-3146*	ANTENNA TV UHF/VHF HI-GAIN 31 ELEMENT	$89.95	$69.95	$20.00
LT-3148*	ANTENNA UHF/VHF/FM DUAL POLARITY	$99.95	$69.95	$30.00
LT-3178	ANTENNA UHF 23 ELEMENT	$39.95	$19.95	$20.00
HC-4043	CAR TERMINAL BATTERY 4WIRE NEGATIVE	$28.95	$19.95	$9.00
HC-4045	CAR TERMINAL BATTERY COVER SUITS HC-4042/43	$7.80	$3.95	$3.85
LA-5092	CAR WASHER NOZZLE LED BLUE PK2	$9.95	$4.95	$5.00
LA-5094	CAR WASHER NOZZLE LED SET FLASHING TRI-COL	$19.95	$9.95	$10.00
LT-3015*	DIPLEXER OUTDOOR UHF/VHF 75R H/Q	$19.95	$14.95	$5.00
LT-3014	DIPLEXER OUTDOOR UHF/VHF 75R WITH CLAMP	$14.95	$9.95	$5.00
AA-2017	EARPHONE STEREO WITH VOLUME CONTROL	$19.95	$12.95	$7.00
AA-2051	HEADPHONE IR STEREO WITH TRANSMITTER & PSU	$79.95	$49.95	$30.00
AM-4070	MICROPHONE STEREO ELECTRET WITH 2 x 6.5MM PLG	$39.95	$29.95	$10.00
QM-3758	MONITOR LCD TFT 7.8IN ROOF MOUNT 12V SWIVEL	$329.00	$299.00	$30.00

Jaycar Electronics

**Off original RRP Limited stock, no rainchecks, may not be available at all stores - call your local Jaycar store to check stock availability

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WINTER CLEARANCE SALE

Cat No	Description	Original RRP	Now	*Save on Orig RRP
AUDIO & VIDEO PRODUCTS (continued)				
AR-1792	RADIO DAB WITH FM TUNER & PSU	$299.00	$229.00	$70.00
AR-1798	RECEIVER SHORTWAVE LCD MANUAL	$39.95	$19.95	$20.00
AR-1710	REMOTE PRE-PROGRAMME 3-IN-1	$29.95	$19.95	$10.00
AR-1712	REMOTE LEARNING 4-IN-1	$39.95	$19.95	$20.00
AR-1730	REMOTE CONTROL TV IR PRE-PROGRAMME KEYRING	$19.95	$9.95	$10.00
AX-3531	SPEAKER GRILLE CLIP SKP SUB PLASTIC PK100	$19.95	$9.95	$10.00
AX-3542	SPEAKER GRILLE CLIP SKP KIT W/T-NUT PK4	$4.70	$2.95	$1.75
AX-3570	SPEAKER GRILLE 6.5IN W/6 LED BLUE SILVER PAIR	$9.95	$7.95	$2.00
AX-3572	SPEAKER GRILLE 6x9IN W/6 LED BLUE SILVER PAIR	$14.95	$9.95	$5.00
AX-3574	SPEAKER GRILLE 10IN W/6 LED BLUE SILVER EA	$14.95	$9.95	$5.00
AX-3576	SPEAKER GRILLE 12IN W/6 LED BLUE SILVER EA	$19.95	$12.95	$7.00
CF-2765*	SPEAKER GRILLE CLIP PLASTIC SHORT PK8 BARGAIN	$1.50	$0.55	$0.95
CF-2766*	SPEAKER GRILLE CLIP PLASTIC LONG PK8 BARGAIN	$2.50	$0.50	$2.00
CS-2218*	SPEAKER CAR TWEET SUPER DOME 1IN 40W MYLAR	$5.00	$2.95	$2.05
CS-2228*	SPEAKER SUB D/MAG 12IN 4R 150WRMS	$279.00	$149.00	$130.00
CS-2465	SPEAKER SURROUND SOUND 3PCE ADD-ON 25W	$99.95	$18.95	$81.00
LIGHTING PRODUCTS				
SL-2868	INVERTER FOR CCFL TUBE 100MM (SL286X)	$9.95	$4.95	$5.00
SL-2888	INVERTER FOR CCFL TUBE 300MM (SL288X)	$12.95	$6.45	$6.50
SL-2872	LIGHT CCFL SET 12VDC 100MM BLUE	$27.95	$13.95	$14.00
SL-2873	LIGHT CCFL SET 12VDC 100MM GREEN	$27.95	$13.95	$14.00
SL-2871	LIGHT CCFL SET 12VDC 100MM RED	$27.95	$13.95	$14.00
SL-2874	LIGHT CCFL SET 12VDC 100MM UV	$27.95	$13.95	$14.00
SL-2870	LIGHT CCFL SET 12VDC 100MM WHITE	$27.95	$13.95	$14.00
SL-2892	LIGHT CCFL SET 12VDC 300MM BLUE	$39.95	$19.95	$20.00
SL-2893	LIGHT CCFL SET 12VDC 300MM GREEN	$39.95	$19.95	$20.00
SL-2891	LIGHT CCFL SET 12VDC 300MM RED	$39.95	$19.95	$20.00
SL-2894	LIGHT CCFL SET 12VDC 300MM UV	$39.95	$19.95	$20.00
SL-2890	LIGHT CCFL SET 12VDC 300MM WHITE	$39.95	$19.95	$20.00
SL-2862	LIGHT CCFL TUBE 100MM BLUE	$11.95	$5.95	$6.00
SL-2864	LIGHT CCFL TUBE 100MM GREEN	$11.95	$5.95	$6.00
SL-2861	LIGHT CCFL TUBE 100MM RED	$11.95	$5.95	$6.00
SL-2865	LIGHT CCFL TUBE 100MM UV	$11.95	$5.95	$6.00
SL-2860	LIGHT CCFL TUBE 100MM WHITE	$11.95	$5.95	$6.00
SL-2882	LIGHT CCFL TUBE 300MM BLUE	$19.95	$9.95	$10.00
SL-2884	LIGHT CCFL TUBE 300MM GREEN	$19.95	$9.95	$10.00
SL-2881	LIGHT CCFL TUBE 300MM RED	$19.95	$9.95	$10.00
SL-2885	LIGHT CCFL TUBE 300MM UV	$19.95	$9.95	$10.00
SL-2880	LIGHT CCFL TUBE 300MM WHITE	$19.95	$9.95	$10.00
SL-2927	LIGHT DISCO SET MINI SPOT & BALL	$24.95	$12.50	$12.45
SL-2712	LIGHT GARDEN STEEL 12V 50W MR16 IP68 HOR	$79.95	$39.95	$40.00
SL-2708*	LIGHT GARDEN STEEL 12V 50W MR16 IP68 SPIKE	$69.95	$34.95	$35.00
SL-2710	LIGHT GARDEN STEEL 12V 50W MR16 IP68 VER	$79.95	$39.95	$40.00
SL-2706	LIGHT GARDEN STEEL 12V FLUSH UNDERWATER	$89.95	$44.95	$45.00
SL-2704	LIGHT GARDEN STEEL 12V FLUSH UNDERWATER	$79.95	$39.95	$40.00
SL-2700	LIGHT GARDEN STEEL 12V PAGODA LARGE	$39.95	$19.95	$20.00
SL-2702	LIGHT GARDEN STEEL 12V PAGODA SMALL	$34.95	$17.50	$17.45
ST-3926	LIGHT LED CANDLE HOLDER SUITS ST-3920	$5.95	$2.00	$3.95
ST-3923	LIGHT LED CANDLE HOLDER SUITS ST-3920	$5.50	$3.00	$2.50
ST-3922*	LIGHT LED CANDLE RECHARGEABLE WITH PSU	$29.95	$9.95	$20.00
GH-1800	LIGHT LED COLOUR CHANGING DISC SMALL	$19.95	$9.95	$10.00
GH-1802	LIGHT LED COLOUR CHANGING DISC WATERPROOF	$24.95	$16.95	$8.00
ST-3887	LIGHT LED RECESSED KIT WITH PSU & 4 LEDS	$89.95	$64.95	$25.00
ST-3908	LIGHT LED SPOT MINI W'PROOF MULTI-COLOURED	$24.95	$14.95	$10.00
GH-1049	LIGHT MOOD DESKTOP WITH SOUND MODULATION	$39.95	$24.95	$15.00
GH-1048	LIGHT MOOD OGGZ RECHARGEABLE 3PC WITH BASE	$69.95	$39.95	$30.00
GH-1527	LIGHT PLASMA BALL PORTABLE 5.5IN BATT OP 4xAA	$39.95	$29.95	$10.00
GH-1532	LIGHT PLASMA DISK 10IN WITH SOUND MODULATION	$49.95	$39.95	$10.00
GH-1530	LIGHT PLASMA DISK 6IN WITH SOUND MODULATION	$39.95	$29.95	$10.00
SL-2928	LIGHT DISCO TRISPOT MINI ROTATING 10W & PSU	$49.95	$29.95	$20.00
GH-1550	TORCH FRIGHT LIGHT WITH 8 SCARY SOUNDS 3xAAA	$24.95	$19.95	$5.00
ST-3074	TORCH HEAD LED DIVING - 8xLED WATERPROOF	$69.95	$49.95	$20.00
ST-3076	TORCH HAND HELD DIVING WITH 7 LEDS	$29.95	$19.95	$10.00
ST-3078	TORCH HAND HELD WITH CCFL/ XENON GLOBES	$24.95	$19.95	$5.00
ST-3275	TORCH BIKE WITH 1W LED WITH BRACKET	$49.95	$34.95	$15.00
ST-3280	TORCH HEAD LEDx3 WHITE WEATHERPROOF 2xAAA	$24.95	$19.95	$5.00
ST-3282	TORCH HEAD LEDx6 WHITE WEATHERPROOF 3xAAA	$39.95	$24.95	$15.00
ST-3305	TORCH SPOTLIGHT RECHARGEABLE 2X6V 4AH 5000K	$49.95	$39.95	$10.00
ST-3306	TORCH SPOTLIGHT RECHARGEABLE 12V 7AH 10000K	$79.95	$54.95	$25.00
ST-3318	TORCH HEAD LED 7xWHITE & 4xRED WITH STRAP	$39.95	$24.95	$15.00
ST-3333	TORCH HAND HELD LED 1W ALUMINIUM 3xAA	$59.95	$24.95	$35.00
ST-3334	TORCH HAND HELD LED 3W ALUMINIUM 3xAA	$89.95	$49.95	$40.00
ST-3338	TORCH HAND HELD LED 5W ALUMINIUM 6xAA	$129.95	$79.95	$50.00
ST-3370	TORCH DYNAMO, RADIO 5-IN-1 WITH SIREN & BLINKER	$59.95	$39.95	$20.00
ST-3875	TORCH WARNING MULTI-FUNCTION ORANGE	$39.95	$24.95	$15.00
GIFTS & GADGETS				
QM-7292	ALCOHOL BREATH TESTER WITH 5LED INDICATOR	$49.95	$29.95	$20.00
QM-7280	ALTIMETER FOR ROCK CLIMBING & HIKING	$49.95	$24.95	$25.00
GH-1230	ANT HABITAT WITH SELF-CONTAINED GEL	$39.95	$29.95	$10.00
GH-1232	ANT HABITAT - LED ILLUMINATOR BASE WITH PSU	$24.95	$14.95	$10.00
GH-1044	AROMATHERAPY WITH WAX & LAVENDER OILS USB	$19.95	$9.95	$10.00
GH-1045*	AROMATHERAPY LAMP WITH BULB & 3 FRAGRANCES	$39.95	$29.95	$10.00
GH-1046*	AROMATHERAPY LAMP REPLACEMENT BULB	$1.95	$1.00	$0.95
GH-1057	BATHROOM ANTI-FOG SHAVING MIRROR WITH RADIO	$34.95	$19.95	$15.00
GH-1350	BATHROOM THERMOMETER SHOWER/TAP WITH LCD	$14.95	$6.95	$8.00
GH-1354	BATHROOM SHOWER HEAD + LCD TEMP READOUT	$24.95	$14.95	$10.00
GH-1507	BATHROOM TOOTHBRUSH & SHAVER HOLDER UV	$19.95	$9.95	$10.00
GH-1512	BATHROOM ANTI-FOG MIRROR WITH CLOCK & ALARM	$39.95	$19.95	$20.00
GG-2126	BINOCULARS WIDE FIELD OF VIEW 4xMAGNIFICATION	$29.95	$14.95	$15.00
QC-3198	CAMERA DIGITAL 300K PIXEL WITH BINOCULARS / BAG	$74.95	$39.95	$35.00
GH-1260	CAMPING BUCKET FOLDABLE WITH CARRY BAG	$14.95	$9.95	$5.00
ST-3190*	CAMPING LIGHT UNDER BENCH 6V DUAL	$14.95	$9.95	$5.00
GG-2147	CAR TRAY STEERING & SEAT MOUNT	$24.95	$14.95	$10.00
GT-3560	CASINO BLACK JACK SET MINI WITH CARDS & CHIPS	$19.95	$6.95	$13.00
GT-3570	CASINO POKER SET DE LUXE WITH 200 CLAY CHIPS	$59.95	$49.95	$10.00
GT-3572	CASINO POKER SET WITH 100CLAY CHIPS 11.5G	$29.95	$14.95	$15.00
GT-3574	CASINO POKER SET WITH 200 CLAY CHIPS IN AL CASE	$59.95	$29.95	$30.00
AR-1734	CLOCK F1 ALARM WITH SOUND EFFECTS RED 2xAA	$39.95	$19.95	$20.00
XC-0160	CLOCK ALARM BOOM BOX WITH 8 BEATS RETRO	$29.95	$9.95	$20.00
XC-0248	CLOCK LED ALARM & RADIO - UNDER KITCHEN CAB	$24.95	$14.95	$10.00
XC-0254	CLOCK ALARM DIGITAL COLOUR CHANGING 4xAAA	$24.95	$14.95	$10.00

Cat No	Description	Original RRP	Now	*Save on Orig RRP
GH-1315	COIN BANK + ELECTRONIC COUNTER 37 CURRENCIES	$14.95	$10.95	$4.00
QM-7282	COMPASS DIGITAL + STOPWATCH, THERMO & ALARM	$49.95	$39.95	$10.00
GH-1150	DRINKING GLASS SHOT WITH RED FLASHING LED	$3.95	$1.95	$2.00
GH-1152	DRINKING COCKTAIL MAKER WITH ACCESSORIES	$14.95	$5.95	$9.00
GE-4231	GAME ELECTRONIC QUIZ MASTER II WITH SOUND	$24.95	$19.95	$5.00
GE-4232	GAME ELEC PDA TYPE CROSSWORD NY TIMES	$119.95	$59.95	$60.00
GH-1030	GAME DARTBOARD ELECTRONIC WITH DARTS	$69.95	$49.95	$20.00
GH-1032	GAME DARTBOARD SPARE DARTS TO GH-1030 PK 30	$9.95	$6.95	$3.00
GH-1034	GAME DARTBOARD DESKTOP - MAGNETIC TIP DARTS	$9.95	$8.95	$1.00
GH-1035	GAME DARTBOARD SPARE DARTS SUIT GH-1034 PK9	$2.95	$1.95	$1.00
GH-1037	GAME DARTBOARD ROLL-UP - MAGNETIC TIP DARTS	$19.95	$14.95	$5.00
GH-1038	GAME DARTBOARD ELEC DESKTOP WITH DARTS	$24.95	$14.95	$10.00
GT-3005	GAME 3IN1 CHESS/CHECKER BOARD/DECK OF CARDS	$19.95	$12.95	$7.00
GT-3008	GAME SNAKES & LADDERS WITH 4 SHOT GLASSES	$19.95	$7.95	$12.00
GT-3027	GAME DESKTOP TABLE TENNIS FOLDABLE AWAY	$29.95	$19.95	$10.00
GT-3062	GAME ELECTRONIC TARGET BULL'S EYE	$39.95	$29.95	$10.00
GT-3440	GAME PLANE AIRBURST GLIDER JET HAWK 1	$59.95	$49.95	$10.00
GT-3495	GAME ELECTRONIC TIME BALL WITH LIGHT & SOUND	$49.95	$39.95	$10.00
GT-3554	GAME ELECTRONIC CASINO 12-IN-1 CONSOLE 4xAA	$39.95	$24.95	$15.00
GT-3577	GAME ELECTRONIC POKER 3-IN-1 2xAAA	$29.95	$12.95	$17.00
GT-3578	GAME POKER TEXAS HOLDEM KEYRING	$19.95	$7.95	$12.00
GH-1460	GRIP STRENGTHENERS WITH MOTIVATIONAL TALK	$19.95	$14.95	$5.00
XC-0182	KEYRING - DATABANK 7-IN-1	$19.95	$9.95	$10.00
LA-6002*	LANYARD WALLET SUITE LA-6001 PK10	$14.95	$5.95	$9.00
XC-0210	LAPTECH SWIM LAP TIMER/COUNTER WATERPROOF	$59.95	$24.95	$35.00
GG-2170	LEVITATING GLOBE WITH PEN AND HOLDER	$49.95	$39.95	$10.00
GG-2262	MASSAGER EYE AIR WITH HEATER & VIBRATOR	$99.95	$59.95	$40.00
GG-2268	MASSAGER & PHONE CHARGER	$12.95	$4.95	$8.00
XC-0195	MESSAGE BADGE LED 5CHARACTER 80MM	$24.95	$14.95	$10.00
XC-0196	MESSAGE DISPLAY ROTATING HANDHELD	$29.95	$6.95	$23.00
GE-4002	MP3 PLAYER 128MB BACK PHONES USB RECHARGE	$99.00	$49.95	$49.05
GE-4006*	MPEG4 PLAYER - MP3, VOICE REC, FM RADIO, TFT	$249.00	$199.00	$50.00
GE-4012	MP3 PLAYER 128MB WITH PEDOMETER REQUIRES	$119.95	$69.95	$50.00
GH-1194	NEGATIVE ION SHOE DE -ODOURISERS WITH PSU	$29.95	$24.95	$5.00
GH-1198	NEGATIVE ION GENERATOR WITH FILTER & PSU	$99.95	$79.95	$20.00
GH-1107	NOVELTY REACTION GAME - QUICK AS YOU CAN	$39.95	$19.95	$20.00
GT-3060	NOVELTY ELECTRONIC LIE DETECTOR GAME	$29.95	$19.95	$10.00
GT-3104	NOVELTY TALKING VOODOO BOSS DOLL	$24.95	$12.95	$12.00
GT-3275	NOVELTY DJ SCRATCHING TURNTABLE KEYCHAIN	$9.95	$3.95	$6.00
GT-3280	NOVELTY INFURIATOR ELECTRONIC DRIPPING TAP	$14.95	$9.95	$5.00
XC-0262	PEDOMETER DIGITAL LCD/CLOCK, ALARM/STOP WATCH	$12.95	$9.95	$3.00
XC-0265	PEDOMETER TALKING DIGITAL LCD WITH FM RADIO	$24.95	$14.95	$10.00
XC-0267	PEDOMETER WITH FM RADIO & CALORIE CONVERTER	$19.95	$14.95	$5.00
XC-0288	PHOTO ALBUM 24PAGE W/ VOICE RECORDER	$44.95	$34.95	$10.00
GG-2375	PROXIMETER SECURITY TRANSMITTER & RECEIVER	$29.95	$19.95	$10.00
GT-3043	REMOTE CONTROL SUBMARINE RED 1xAAA PAIR	$49.95	$29.95	$20.00
GT-3044	REMOTE CONTROL SUBMARINE 27MHZ YELLOW 1xAAA	$24.95	$12.95	$12.00
GT-3045	REMOTE CONTROL SUBMARINE 40MHZ BLUE 1xAAA	$24.95	$12.95	$12.00
GT-3046	REMOTE CONTROL TANK COMBAT GREEN + SOUNDS	$39.95	$29.95	$10.00
GT-3048	REMOTE CONTROL TANK COMBAT BEIGE + SOUNDS	$39.95	$29.95	$10.00
GT-3200	REMOTE CONTROL JEEP CRASH 27MHZ RED	$59.95	$34.95	$25.00
GT-3202	REMOTE CONTROL JEEP CRASH 40MHZ BLACK	$59.95	$34.95	$25.00
GT-3225	REMOTE CONTROL FISH CLOWN 40MHZ	$29.95	$12.95	$17.00
GT-3410*	REMOTE CONTROL HOVERCRAFT 27MHZ BLUE	$29.95	$12.95	$17.00
GT-3415	REMOTE CONTROL SAIL SHIP TO SCALE 40MHZ	$39.95	$29.95	$10.00
GT-3007	ROCKET SYSTEM SPARE ROCKETS SUIT GT-3006 PK2	$9.95	$4.95	$5.00
GT-3006	ROCKET SYSTEM WITH PUMP & 2 AIR ROCKETS	$29.95	$19.95	$10.00
GH-1312	SAFE MINI ELECTRONIC WITH KEYPAD GREY	$19.95	$7.95	$12.00
GH-1320	SEALER PLASTIC BAG ELECTRONIC 2AA	$12.95	$9.95	$3.00
TH-1759	SHARPENER MAGIC ALL-PURPOSE	$18.95	$12.95	$6.00
XL-2515	SLEEVE LAMINATING S/SEAL LUGGAGE TAG PK5	$3.95	$2.30	$1.65
XL-2517	SLEEVE LAMINATING S/SEAL ID TAGS PK5	$3.95	$2.55	$1.40
XL-2519	SLEEVE LAMINATING S/SEAL PHOTO 4x6IN PK5	$4.95	$2.75	$2.20
ST-3099*	TIE CLIP LED FLASHING MAGNETIC 10MM	$3.95	$1.20	$2.75
GG-2300	TOOL MULTI 10-IN-1 OFFICEMATE	$24.95	$19.95	$5.00
GG-2302	TOOL MULTI 7-IN-1 USB FLASH MEMORY 128MB	$59.95	$39.95	$20.00
TD-2053	TOOL KIT FISHING WITH SCALES, TORCH & PLIERS	$29.95	$19.95	$10.00
TD-2054*	TOOL 7-IN-1 OCTOPUS SCREWDRIVER WITH TORCH	$24.95	$12.95	$12.00
TH-1903	TOOL MULTI 16-IN-1 STAINLESS STEEL WITH POUCH	$29.95	$19.95	$10.00
TH-1904	TOOL MULTI 6-IN-1 FOLDABLE KEYRING	$6.95	$4.95	$2.00
TH-1906	TOOL MULTI 5IN1 FOLDABLE W/LED LIGHT	$14.95	$7.95	$7.00
TH-1907	TOOL ULTIMATE POCKET KNIFE BLUE WITH POUCH	$19.95	$12.95	$7.00
TH-2137	TOOL SET BICYCLE 5 PC STAINLESS STEEL WITH BAG	$29.95	$12.95	$17.00
TH-2139	TOOL SET GARDEN 3 PC STAINLESS STEEL - POUCH	$19.95	$7.95	$12.00
DC-1030*	TRANSCEIVER 40 CH UHF CB WITH CTCSS 0.5WATTS	$79.95	$39.95	$40.00
DC-1070*	TRANSCEIVER WATCH 40 CH UHF WITH CHARGER PAIR	$169.00	$84.95	$84.05
XC-0180	TRANSLATOR 8-EURO LANGUAGE 7-IN-1	$19.95	$8.95	$11.00
XC-0186	TRANSLATOR LANGUAGE 11 WITH VOICE FUNCTION	$29.95	$19.95	$10.00
XC-0187	TRANSLATOR VOICE CARD ENGLISH/FRENCH/GERMAN	$24.95	$12.95	$12.00
XC-0188	TRANSLATOR VOICE CARD ENGLISH/SPANISH/ITALIAN	$24.95	$12.95	$12.00
XC-0189	TRANSLATOR VOICE CARD MANDARIN/JAPANESE	$19.95	$9.95	$10.00
GH-1245	TRIMMER HEDGE MINI ELECT CORDLESS R'GEABLE	$69.95	$34.95	$35.00
GH-1395*	VACUUM CLEANER RECHARGEABLE WITH REMOTE	$199.00	$129.00	$70.00
GH-1396	VACUUM CLEANER SPARE DUST FILTERS PK12	$29.95	$12.95	$17.00
GH-1397	VACUUM CLEANER SPARE MOP PAPER PK100	$24.95	$12.95	$12.00
XC-0257	WATCH TALKING DIGITAL WITH BACKLIGHT & ALARM	$29.95	$19.95	$10.00
XC-0260	WATCH DIGITAL WITH PULSE & TEMP MONITOR	$19.95	$14.95	$5.00
XC-0266	WATCH DIGITAL WITH PULSE, ALARM/CALORIE COUNTER	$39.95	$19.95	$20.00
XC-0268	WATCH DIGITAL COMPASS/STOPWATCH/TEMP/DATE	$34.95	$29.95	$5.00
XC-0298*	WEATHER STATION WITH DIGITAL BAROMETER & COMPASS	$79.95	$29.95	$50.00
XC-0300	WEATHER RAIN GAUGE WIRED	$79.95	$49.95	$30.00
XC-0305	WEATHER RAIN GAUGE WIRELESS	$119.00	$69.95	$49.05
GE-4211*	WINE MASTER ELECTRONIC WITH LCD BARGAIN	$24.95	$19.95	$5.00

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Jaycar Electronics

Stop those ZAPS double insulated

If you have experienced mild tingles or shocks from double insulated equipment, you will want to know how to prevent them. Here's our "Tingle Terminator": a simple solution to this vexing problem. There is no need to gain access inside the equipment and it will not void the warranty.

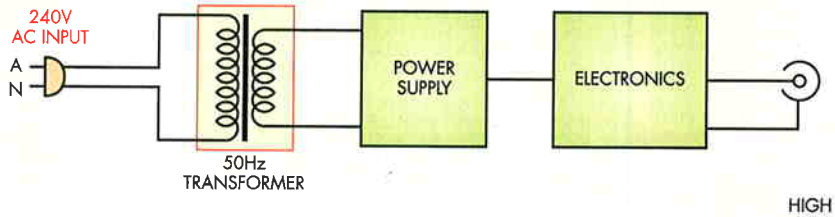
Modern double insulated equipment such as DVD players and digital set top boxes (STBs) can give you a mild electric shock.

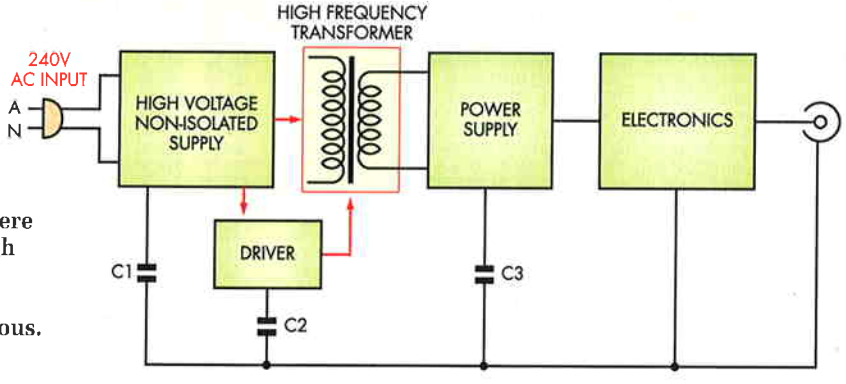
The experience is not unlike the static zap you sometimes get when alighting from a car in dry weather or from the metal hose of a vacuum cleaner. Such a shock may well reduce your confidence in the safety of the appliance even though there is no inherent fault.

Whether or not you experience such a shock will depend on the installation. But perhaps we need to describe the problem first.

These days most home entertainment equipment is double insulated. This includes most TV sets (CRT, plasma, LCD, projection, etc), VCRs, STBs, DVD players and amplifiers. This means they are powered from the mains using a 2-pin mains plug – one that does not include a mains earth connection. Normally though, such equipment has a metal case or some exposed metal in its construction.

When double insulated, the case is left floating and its safety is reliant upon the insulation between the mains and the metal case. Double insulation does not necessarily mean there are only two layers of insulation. Often there are more than two insulation layers between the mains wiring and any exposed parts. For example, the mains lead is double insulated with a sheath of tubing over the two active and neutral wires. This lead passes through into the chassis using a plastic cord grip grommet that adds further isolation between the mains and the case. The connections inside are also made to ensure insulation is up to standard. Any appliance with





Compare the difference in conventional (older) style power supplies (Fig.1, above) with the "switch mode" supplies found in the vast majority of modern electronics (Fig.2, right). In the older style supply, the entire power supply is isolated by the mains transformer but in the switch-mode supply, there are components on the primary side of the high frequency transformer. These can have small leakage currents which can give you a tingle. They're not (in normal circumstances) dangerous. But they are certainly annoying!

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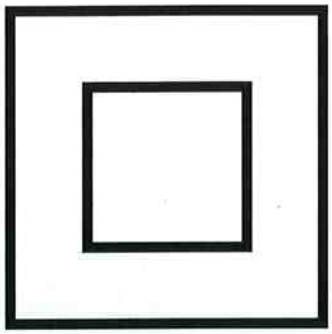
from equipment!

By JOHN CLARKE



If it has this symbol on it (usually on the back) it is double insulated!

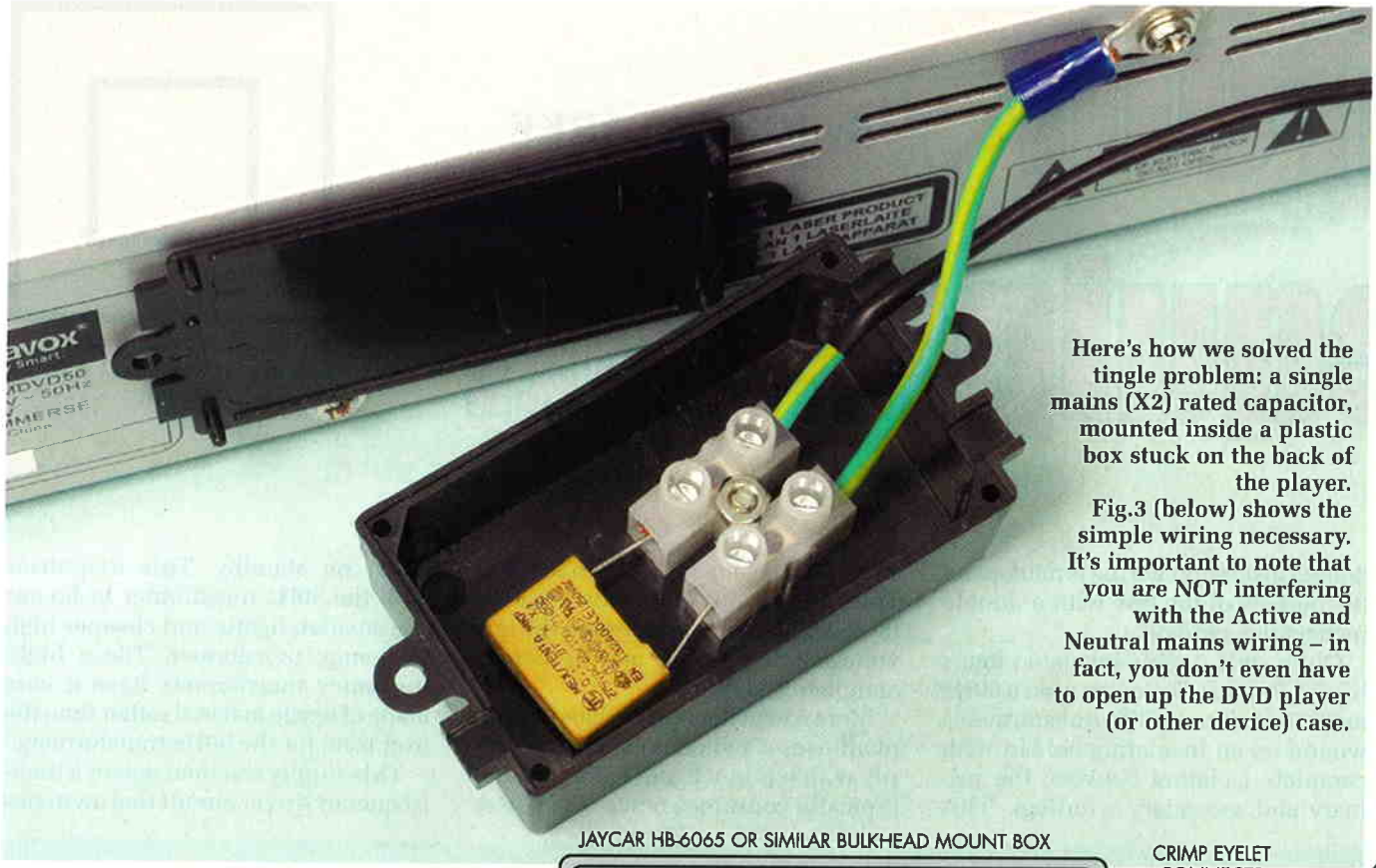
double insulation wiring is marked on the outside of the box with a double rectangular symbol.

Older style double insulated items like VCRs and CD players used a 50Hz mains transformer. The transformer is wound on an insulating bobbin with complete isolation between the primary and secondary windings. This supply arrangement is shown in Fig.1. Thus there is no connection between the 240VAC mains supply and the low voltage power supply and so there is complete isolation.

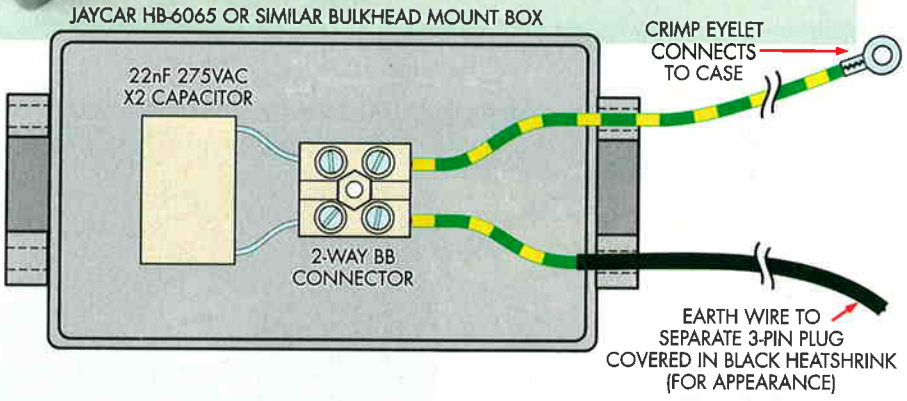
More recent double insulated equipment uses a switchmode power supply which is much more efficient and typically consumes much less power when on standby. This dispenses with the 50Hz transformer in favour of a smaller, lighter and cheaper high frequency transformer. These high-frequency transformers have a core made of ferrite material rather than the iron used for the 50Hz transformers.

This supply can then power a high-frequency driver circuit that switches

Inside a modern DVD player. The switch-mode supply is on the brown PC board at the right of the unit – note the size of the high-frequency transformer compared to older conventional power supplies. Also note the interference suppression components close to where the mains voltage is applied. While essential, it's these which cause the tingle problems.



Here's how we solved the tingle problem: a single mains (X2) rated capacitor, mounted inside a plastic box stuck on the back of the player. Fig.3 (below) shows the simple wiring necessary. It's important to note that you are NOT interfering with the Active and Neutral mains wiring – in fact, you don't even have to open up the DVD player (or other device) case.



the primary of a high-frequency transformer at a very fast rate. The switching is typically several hundred kilohertz, much higher than the 50Hz mains frequency. The secondary output of the transformer is isolated from the primary via insulation between the primary and secondary windings.

One problem with this type of supply is that it produces electromagnetic interference (EMI), caused by fast switching at the high frequencies. The switching produces harmonics that extend well into the radio spectrum. These must be attenuated in order to comply with EMI standards. This involves using filter circuits with capacitors connected from the switching supply to the output signal earth and the metal case.

As you can see in Fig.2, some of this bypassing is on the 240VAC mains side of the supply. These include capacitors C1 and C2. The total amount of capacitive coupling is only relatively small and amounts to about 3.3nF and so the current flow is only a mere 260μA.

However, the small current coupled with the high voltages will mean that the metal case of the double insulated item can be sitting as high as 170VAC. If you make a connection between this charged case and mains earth then you will experience a small zap while the voltage on the case passes through you to ground.

In some cases the shock repeats itself once every second or so if the person keeps making contact. The shock is a harmless one and is more a nuisance than a safety concern. Even so, it can be an unnerving experience from a mains-powered product and can raise doubts about the safety of the appliance.

Some equipment that has a brushed finish metal case will give nasty tingles even without a direct connection to earth.

In normal circumstances you may not notice the floating voltage, for one of two reasons.

Firstly, all of your equipment could be floating at this high voltage and with no earthed equipment nearby, there will not be any means to conduct the current. This is typically the case where people have double insulated equipment such as a TV set, DVD player and a VCR all connected together in a timber cabinet.

Secondly, when you connect a double-insulated DVD player to an earthed stereo amplifier, for example, the signal earth (and case) of the player will be earthed via the amplifier. This means that any hazard is avoided.

However, there can be a shock hazard if you have a bank of double-insulated equipment connected together and earthed equipment nearby. In that case you might get a tingle every time you touch both sets of equipment.

The problem can be worse where a

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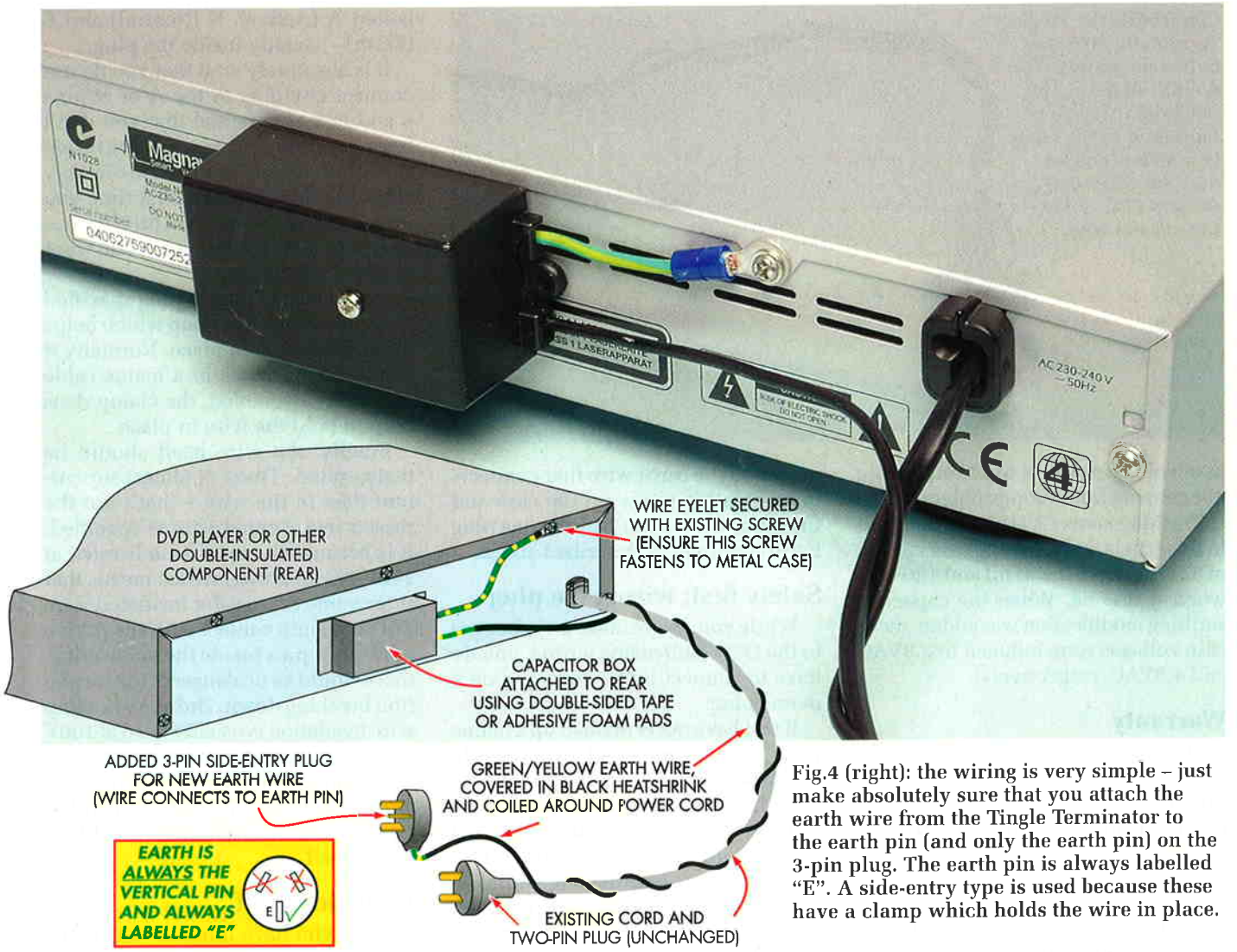

DVD PLAYER OR OTHER DOUBLE-INSULATED COMPONENT (REAR)
WIRE EYELET SECURED WITH EXISTING SCREW (ENSURE THIS SCREW FASTENS TO METAL CASE)
CAPACITOR BOX ATTACHED TO REAR USING DOUBLE-SIDED TAPE OR ADHESIVE FOAM PADS
ADDED 3-PIN SIDE-ENTRY PLUG FOR NEW EARTH WIRE (WIRE CONNECTS TO EARTH PIN)
GREEN/YELLOW EARTH WIRE, COVERED IN BLACK HEATSHRINK AND COILED AROUND POWER CORD
EARTH IS ALWAYS THE VERTICAL PIN AND ALWAYS LABELLED "E"
EXISTING CORD AND TWO-PIN PLUG (UNCHANGED)

Fig.4 (right): the wiring is very simple – just make absolutely sure that you attach the earth wire from the Tingle Terminator to the earth pin (and only the earth pin) on the 3-pin plug. The earth pin is always labelled "E". A side-entry type is used because these have a clamp which holds the wire in place.

sound system is connected to a microphone for public address or for karaoke use. It is important that the shell of the microphone is not sitting at around 170VAC with respect to earth!

Another problem arises when disconnecting double insulated equipment from equipment that earths the signal. Often a shock will be experienced if the signal leads are disconnected before the mains plug is removed, even if the equipment has been switched off! This is a common situation with a public address system that comprises a mixer, amplifier and a CD/DVD player. This happens often when the DVD player is borrowed and the person using the equipment is not aware of the hazard.

The obvious solution to this last problem is to disconnect power before removing the signal leads. However, this is not practical since non-technical people will not necessarily follow this procedure or even be aware that they should disconnect it this way

Solving the zap problem

A simple solution to all the above problems is to connect the case of a double-insulated appliance to mains earth. This will very effectively remove the shock hazard. However, we do not recommend it, for a number of reasons.

First, it could be argued that earthing a double-insulated case decreases safety because an incorrectly wired plug or mains socket can produce a situation where the metal case is directly connected to mains Active. We don't accept this argument because earthed mains appliances such as fridges, washing machines and microwave ovens are still very prevalent and quite safe.

Second, if you modify the mains wiring to a double-insulated appliance such as a DVD player, you will probably void the warranty and possibly cause other circuit hazards – if the job is not done to normal safety standards.

Third, earthing the case will definitely cause a hum loop where the equipment is connected to another piece of the earthed gear such as a large stereo amplifier. This will produce a nasty hum in the audio signal and is caused by currents circulating around the loop created by the signal connections and multiple connections to mains earth.

Ultimately, the only practical solution is to couple the case of the DVD player (or whatever) to mains earth via a small capacitor. The capacitor value needs to be small enough to cause minimal AC current into the earth but large enough to reduce the case voltage to a low value. We found a 22nF 250VAC class X2 capacitor to be a good compromise.

For example, a DVD player which had its case floating at 170VAC had the

Connecting the Tingle Terminator requires only a powerboard or double adaptor. The powerboard itself is unaltered so the other two outlets can be used for other 240V devices (TV, etc) in the normal way.

case voltage reduced to 27VAC while not causing hum loop problems.

The Magnavox DVD player pictured in this article had a floating case voltage of 82VAC when it was off and 120VAC when it was on. When the capacitor earthing modification was added, these case voltages were reduced to 2.8VAC and 4.5VAC, respectively.

Warranty

OK, that's the solution but how do you it without voiding the warranty? You must not modify the existing mains wiring or modify the existing 2-core mains cord and moulded plug.

With our approach, you do not have to open the case, which may in itself cause the warranty to be voided.

We mounted the 22nF 275VAC capacitor inside a small plastic box which was attached to the rear of the case with double-sided foam adhesive tape. One side of the capacitor is connected to the case via a short lead and eyelet secured by one of the case screws. The other side of the capacitor is connected to mains earth via a single lead terminated (only) to the Earth pin of a side entry 3-pin moulded plug.

The side entry plug is used because it has extra clamping that enables thinner cables to be securely clamped. The earth wire is sheathed with tubing in the region of the cord clamp. The earth wire with its 3-pin plug is wrapped around the existing 2-core mains flex and 2-core plug and both are plugged into a 240VAC GPO or mains power board. This arrangement is shown in Fig.4.

Fig.3 shows the mounting arrangement for the 22nF class X2 capacitor. It is terminated to a 2-way insulated terminal block with one lead connected to the earth wire that connects to an existing screw on the case and the other wire to the 3-pin mains plug Earth terminal, as described above.

Safety first: wiring the plug

While you do not make any changes to the DVD (etc) mains wiring, you do have to connect to the earth pin on a mains plug.

If you have never opened up a mains plug before, ***you need to carefully read and understand the following.*** Even if you have, read it anyway!

There are three pins in a standard (Australian) mains plug. The Active and Neutral are both angled, while the Earth is always vertical and between and below the active/neutral.

All three pins are also always labelled A (Active), N (Neutral) and E (Earth) – usually inside the plug.

It is absolutely vital that you do not connect anything to the A or N pins – and just as essential that you don't have any strands of wire floating inside the plug which could conceivably short to other pins (the first time you plug it in there would be a brief flash, a bang and a blown fuse – but you want to avoid even that!).

Inside the side-entry plug specified you will also find a clamp which helps to hold the wire in place. Normally it clamps three wires in a mains cable but when assembled, the clamp does help to hold the wire in place.

Finally, the wire itself should be mains-rated. There is almost no current flow in the wire – that's not the reason mains-rated wire is specified. It is because the insulation is rated at 240V AC (or better) which means that if for some reason the insulated wire did come into contact with the Active or Neutral pins inside the mains plug, there would be no danger of the insulation breaking down. Ordinary hookup wire insulation is usually rated at 100V or less, so don't take the chance.

We covered the green/yellow earth wire in black heatshrink so it didn't look so obvious against the black mains lead.

Parts List – Tingle Terminator

- 1 3-pin mains side entry plug
- 1 double adaptor or mains power board
- 1 length of 250VAC-rated earth (green/yellow) wire (to match length of appliance power cord)
- 1 short length of earth wire (to suit distance to crimp eyelet)
- 1 plastic bulkhead box (Jaycar HB-6065 or equivalent)
- 1 2-way mains terminal block
- 1 22nF 275VAC X2 capacitor
- 1 M3 x 15mm screw
- 1 M3 nut
- 1 4mm crimp eyelet
- Length of black spaghetti tubing insulation or heatshrink (optional – for appearance only)
- Double-sided foam tape or adhesive foam pad

Finishing it off

Once you have finished wiring the Tingle Terminator and checked the AC voltage with your digital multimeter (both before and after!) to ensure it is working, you should glue the plastic case closed.

While there are of course no dangerous voltages inside the case, this does prevent inquisitive fingers poking around.

A drop of super glue on the case lid to body join will do this perfectly – and it will also mean that if necessary later, you can "crack" the case open.

That's it!

OK, so this approach should solve problems with being zapped by double-insulated audio & video equipment.

And if you do have to make a warranty claim, remember to completely remove the capacitor box and earth wire and its 3-pin plug from around the mains lead. If they don't understand it, they'll blame your Tingle Terminator for any ills your DVD player might have! SC

Vintage Radio

By RODNEY CHAMPNESS, VK3UG

AWA B33: the ultimate Australian-made transistor portable

Designed for the well-heeled, AWA's Radiola B33 was a very impressive transistor portable that tuned the broadcast band and three shortwave bands from 1.6-30MHz. Restoring and aligning it is not the easiest of tasks, however.

AWA produced some superb receivers over the years and the 4-band AWA B33 9-transistor portable was one of them. In addition, a broadcast-band only model of this receiver – designated the B32 – was manufactured and this was described in the August 2005 issue.

I lamented at the time that I didn't have a B33 and a few readers responded by offering me sets that were just gathering dust or had been pulled to pieces. In the end, I obtained two of these receivers and this article describes the restoration of one of those sets.

Although sets like the B33 were produced, Australian-made multi-band transistor receivers were not all that common. Australian manufacturers did produce transistor receivers in quantity during the 1960s and early 1970s but these were mainly broadcast-band sets. However, Japanese manufacturers were starting to flood the Australian market and many of their sets featured one or two shortwave bands in addition to the broadcast band.

Despite this, Australian-made transistor radio receivers performed far better than the Japanese offerings but that didn't stop the flood of imported sets. Japanese sets were cheaper and people wanted the cheaper item – even if it was inferior.

During that era, it is arguable that Australian-made transistor receivers were the best performing AM sets in the world. Most other countries had FM as well as AM and their radio stations were not spaced as far apart as in Australia, even in rural environments. As a result, Australian-made radios had to be better performers in order to adequately receive stations over longer distances.

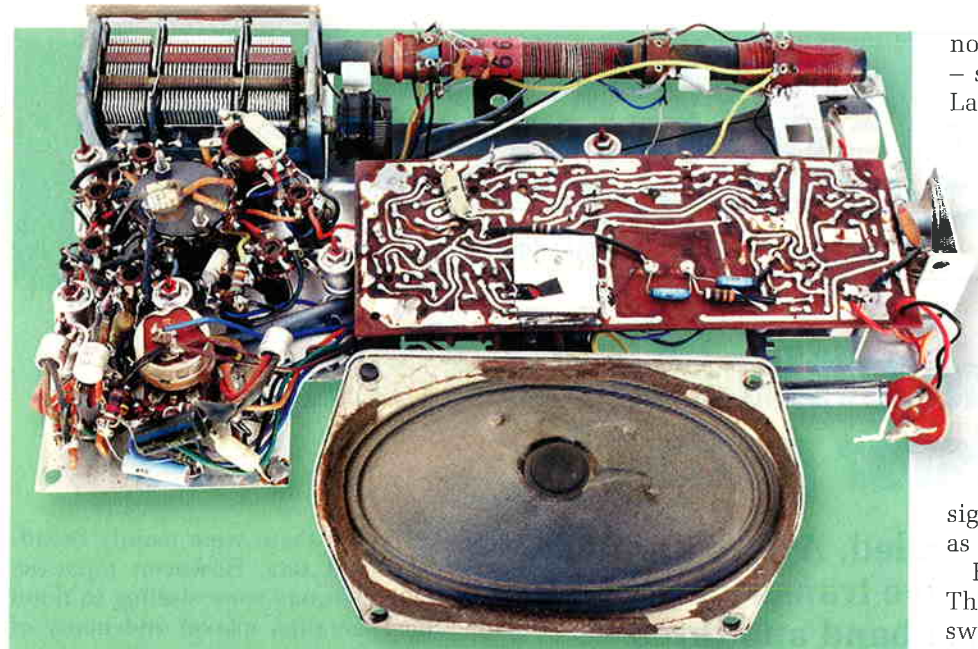
Of course, AM in many cases was the poor relation in regards to performance on AM/FM receivers and still is today (except on high-quality communications receiving equipment).

This is the fully restored B33 receiver. Scrounging parts from a second set allowed it to be restored to almost new condition.

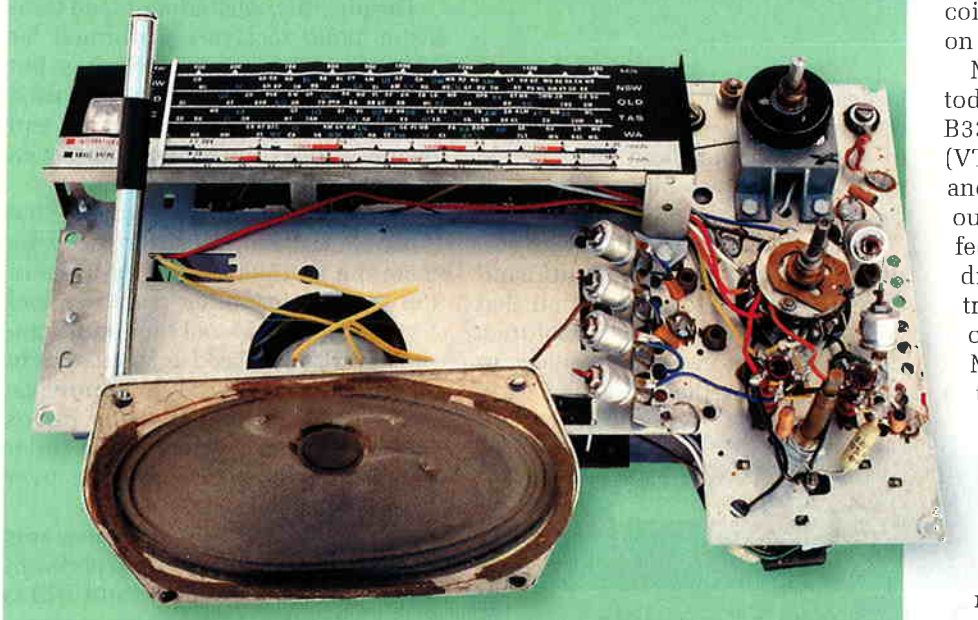
Shortwave reception

As well as listening to AM stations, many people also wanted to listen to the many shortwave services available both within Australia and overseas. However, they didn't want the inconvenience of having a home-installed receiver tethered to an outside antenna. Instead, they wanted a portable receiver that didn't normally require an outside antenna for "run of the mill" listening.

The AWA B33 filled that role but like many receivers of the era, also had provision for an external antenna and



This view shows the rear of the chassis plate, after its removal from the cabinet. The PC board is mounted upside down on this plate.



The front of the chassis plate carries the dial scale and various trimmer capacitors which are used for alignment. The faults in the receiver were all mechanical.

earth, which noticeably improved the already good performance. Provision was also made for the connection of an external 9V power source.

Used with an outside antenna system, the B33 would have easily received the ABC inland radio services situated near several capital cities. All these stations have since closed down and the Lyndhurst site near Melbourne is now a housing estate!

However, the ABC still provides a service to remote areas of inland Australia from Alice Springs, Tennant Creek and Katherine, on 2310kHz, 2325kHz and 2485kHz at night and 4835kHz, 4910kHz and 5025kHz during the day. Unfortunately, the daytime services from these three 50kW stations can not heard in southern Australia but the night-time frequencies can be received without problems.

In addition, Radio Australia at Shepparton, Victoria carries services to northern Australia in times of disaster – such as during the recent cyclone Larry.

The B33 receiver

The AWA B33 was produced around 1965 and is essentially a "high-end" receiver. It has a large 195 x 12mm loopstick antenna with two sets of windings – one for the broadcast band and the second for "shortwave 1" which tunes from 1.6-4.25MHz. The other two shortwave bands tune 4-30MHz and rely on the use of the telescopic whip antenna for signal pick-up when the set is used as a portable.

Fig.1 shows the set's circuit details. The first thing to note is that the band-switched input circuits are connected to an RF stage based on a 2N2083 transistor (VT9). Its collector signal is then fed via another bank of four tuning coils to a transistor mixer stage based on another 2N2083 (VT10).

Most transistor receivers use an autodyne converter stage but not so the B33 which uses a separate oscillator (VT11). This provides better performance and more stable operation. The output from the mixer (VT10) is then fed to a 2-stage 455kHz IF (intermediate frequency) amplifier based on transistors VT3 and VT4. The IF output in turn feeds diode detector MR3 which is then followed by three stages of audio amplification (VT5-VT8).

The audio amplifier includes a push-pull output stage and this is coupled directly to a speaker with an 80Ω centre-tapped voice coil. Hopefully, the speaker will never need changing, as obtaining a suitable replacement would be impossible unless salvaged from another similar receiver.

Case details

The B33's case is dark blue/black leatherette, while the front is plastic with vapour-deposited chrome to give it a metal appearance. This is attached to a plastic inner frame.

The case is quite substantial for a transistor receiver and measures 320mm long x 200mm high (not including the handle) x 110mm deep (including the knobs). It's quality is quite good and is noticeably better than the cases fitted to down-market AWA transistor receivers.

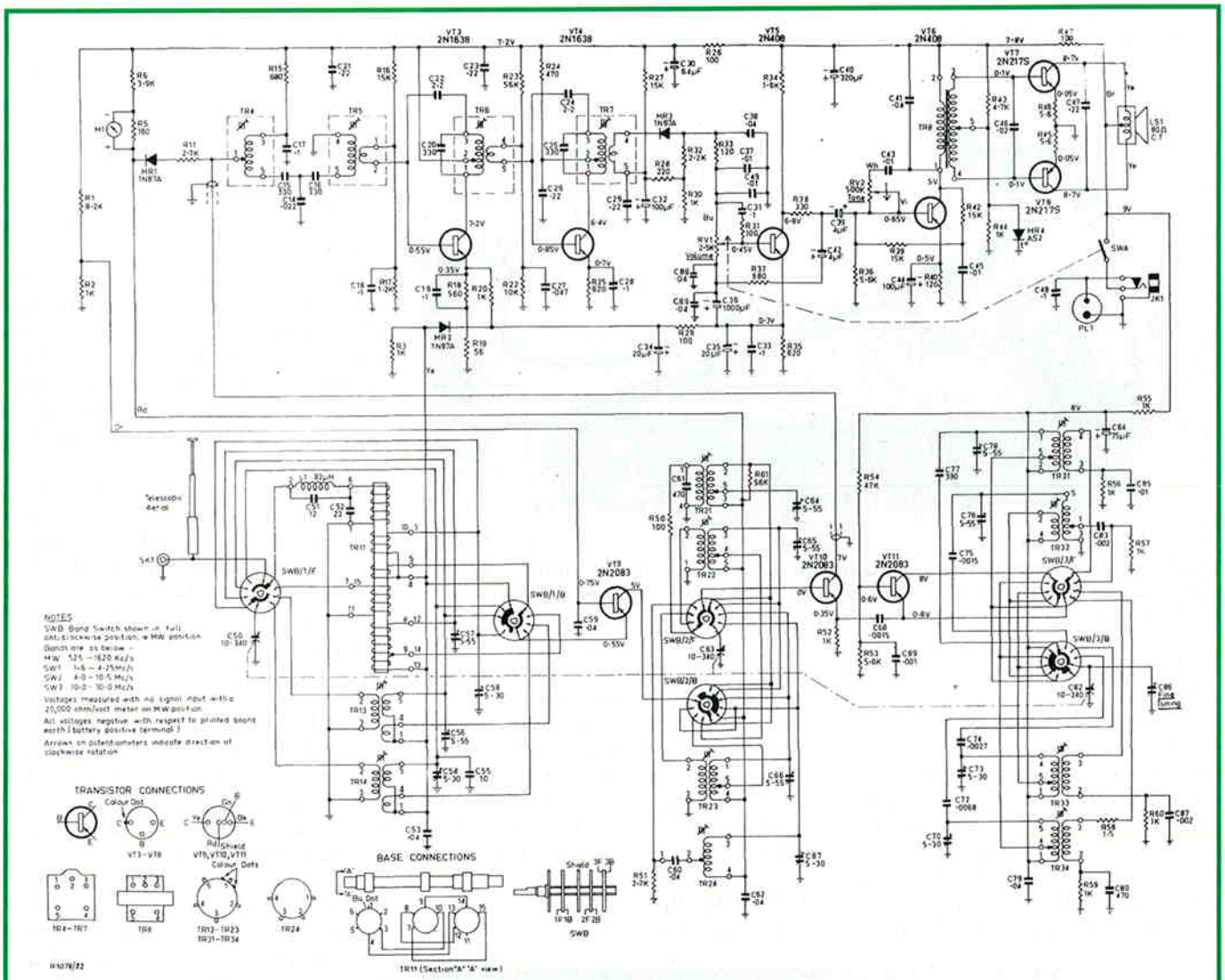


Fig.1: the circuit for the B33 4-band receiver used nine PNP transistors. Note the transformer-coupled push-pull audio output stage and the centre-tapped 80Ω loudspeaker.

Due to its size, the set is quite heavy, weighing in at 3.6kg, or 4.6kg with its heavy-duty batteries. The set was designed to use the now unobtainable 2761 battery. However, two D-cell battery holders – one for four cells and the other for two cells – will fit into the space that the 2761 occupied, provided the speaker's terminals are orientated towards the top of the cabinet.

In practice, the two holders were wired in series to give 9V. The "output" leads were soldered to the ends of the battery plug to keep things as authentic as possible, with heatshrink tubing fitted over the exposed plug prongs to prevent shorts.

Provision has also been made for the attachment of an external 9V power supply. However, there is one important thing to note here: like most transistor receivers using PNP transistors, this set has a positive chassis. This means that the sleeve of the DC plug must be positive (centre negative).

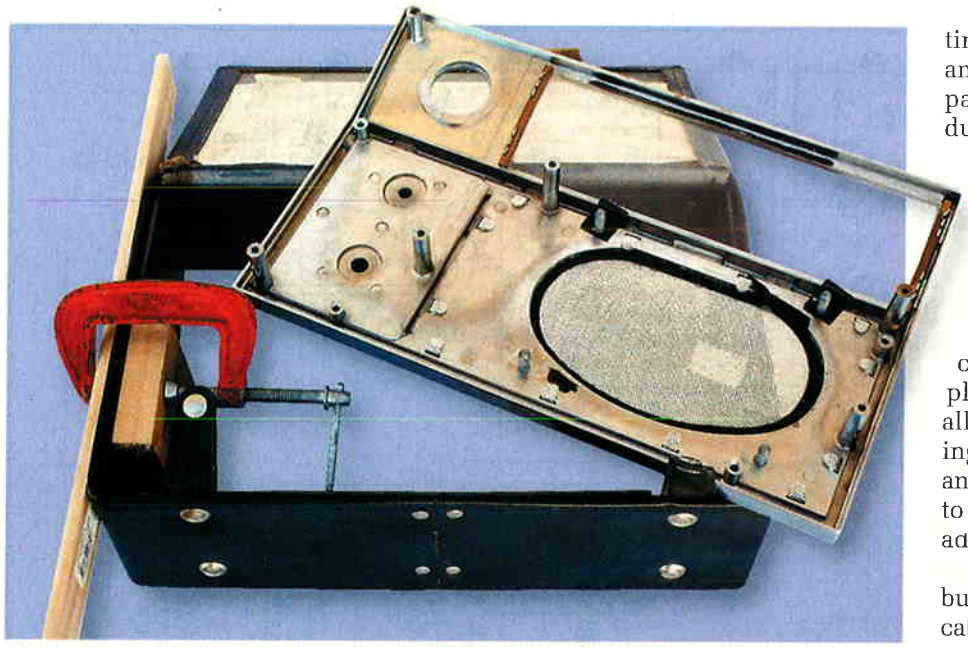
Finally, the B33 is fitted with a bayonet socket on the lefthand end of the receiver. This allows an external antenna and earth to be connected for a worthwhile performance boost.

Cabinet restoration

The first job in the restoration process was to remove the control knobs and this proved to be a very difficult task – it was if they had been glued in place. Fortunately, I was able to squirt some Inox cleaner/lubricant into the backs of the knobs and also on the control shafts to help free them.

The wave change switch had also completely "frozen" and it took some time to work the Inox down the shaft and into the switch sleeve. Eventually, I was able to get it to move but I had to use a small spanner on the shaft to achieve this. Initially, I was concerned that the switch might break but the lubricant eventually did its job, after which the switch operated freely.

With the knobs removed, it was now time to remove the chassis from the cabinet. This is achieved by first undoing six screws and removing the escutcheon around the power and antenna sockets. That done, the chassis is lifted up slightly and the screw holding the telescopic antenna in place removed. The chassis is then slid out far enough to allow the centre-tap wire to the speaker to be desoldered, after which it is fully removed from the case (the leads to the voice coil



The leatherette covering was re-attached to the receiver's plastic inner case using contact adhesive, with a G-clamp and some small pieces of wood used to hold everything together while the adhesive dried.

are long enough to be left connected to the speaker).

Having removed the chassis, I installed a longer centre-tap lead to make future work easier. I then undid the four screws holding the speaker in place and removed it, while undoing four more screws allowed the front panel to be removed as well. Finally, I refitted the antenna to the chassis, as this would be needed later for testing.

By the way, it's important not to lose any screws with this sort of job – it can be very time consuming if you have to replace them. My approach is to store all screws in a small container as they are removed. Leaving them laying around the workbench is just asking for trouble, as they are easily lost.

Cleaning up

Having dismantled the set, it was time to clean all the parts and repair any damage to the cabinet. A small paintbrush was used to clean the dust from the chassis and PC board, while the cabinet was scrubbed in soapy water using a nailbrush and, for in the awkward spots, a toothbrush. The knobs were also scrubbed clean in soapy water and they look almost like new.

Unfortunately, the leatherette covering had come away from the plastic inner case on one side and really looked tatty. This was repaired using contact adhesive, with a G-clamp and two small pieces of wood used to hold everything together while the adhesive dried.

This repair was quite satisfactory but in the end, I decided to use the cabinet from the second set, as it was in better condition overall. The dial scale also had to be re-glued to its frame and this was done using clear nail polish.

Servicing

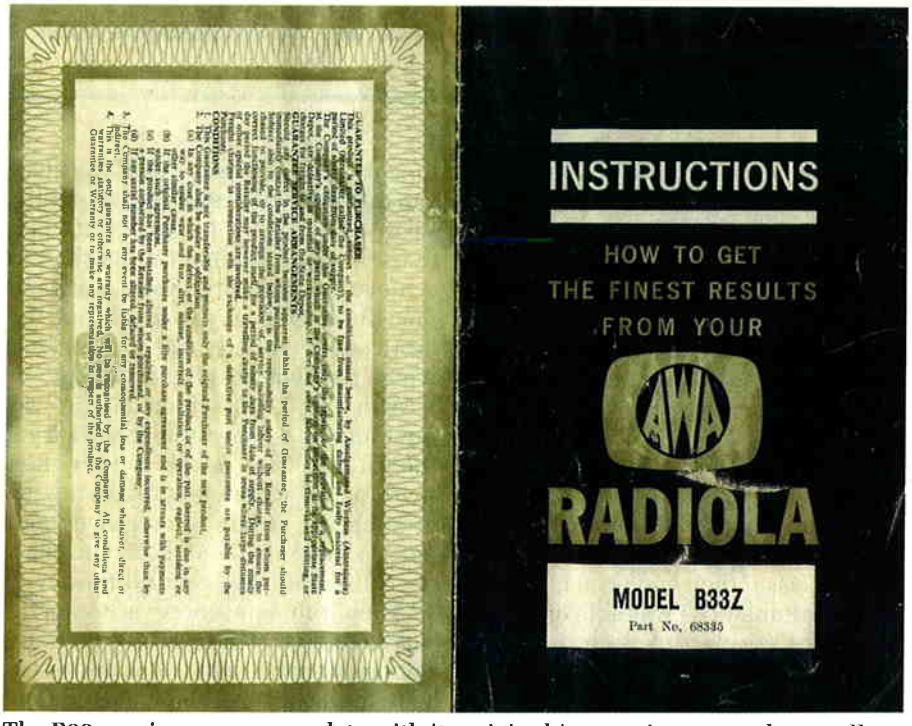
The B33 is far more complex than its single-band brother and requires disassembly to do any real work. It's a pity AWA didn't make it easier for the serviceman. On the other hand, it's likely that very few of these sets ever required servicing during their lifetime!

With the set out of the cabinet, I applied 9V to the PC board and was immediately able to receive some stations. However, as I tuned across the broadcast band, there were more scraping noises than stations.

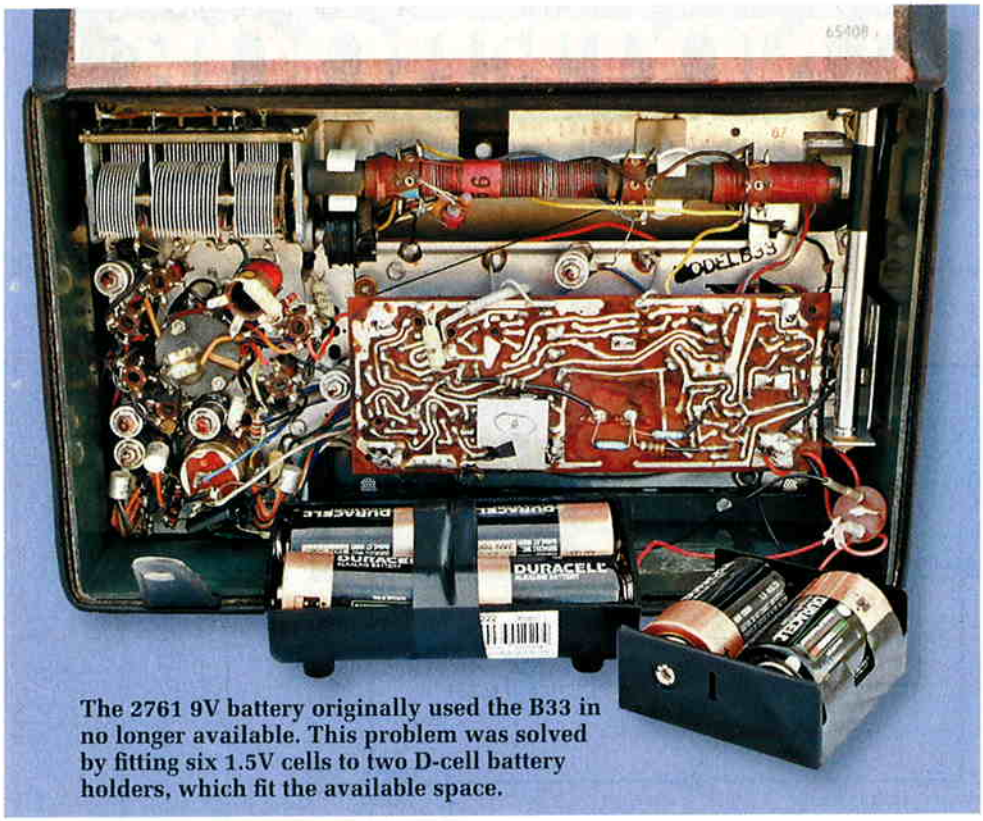
I lubricated all the moving surfaces on the dial tuning mechanism but the problem remained. A subsequent close examination revealed that a number of plates in the antenna and RF sections of the tuning gang were intermittently shorting together. This problem can usually be fixed by gently bending the offending plates but not in this case. In fact, it was quite likely that this tuning gang had been faulty from new, as the oscillator section was perfect.

One way around this problem was to use the gang from the other radio. It looked to be in good order and so it was worth a try. However, swapping in the new gang without having the dial cord end up in a mess would be a challenge.

First, I released the cord from the pulley at the lefthand end of the drive, which meant that I could then ease



The B33 receiver came complete with its original instruction manual, as well as an external DC power supply.



The 2761 9V battery originally used the B33 in no longer available. This problem was solved by fitting six 1.5V cells to two D-cell battery holders, which fit the available space.

the dial drum along the gang's shaft. I then removed the three screws holding the gang to the chassis although this wasn't exactly straightforward – the middle screw couldn't be accessed until I removed the screws from the dial drive assembly and gently swung it aside.

That done, I replaced the drive assembly and gently eased the drum off while I slid the gang out to the right. It came out without the dial cord coming off the main pulleys which was just what I wanted.

Finally, the replacement gang was mounted in position, the drum refitted and the dial cord refitted to the lefthand pulley.

It all worked and this time there were no crackles as I tuned across the band, with stations coming in as expected. However, with a new gang fitted, a complete realignment of all the front-end sections was necessary.

This was done by placing a signal generator on the other side of the workshop, to give a weak signal into the receiver. One problem I struck was that some of the tuned circuits either had too much or too little parallel capacitance across their trimmer capacitors to allow proper peaking at the high-frequency end of the dial. Apart from that, the procedure was straightforward, if a little complicated.

Overall, this set performs quite well, although the second and third harmonics of the IF amplifier, which occur on 910kHz and 1365kHz, do cause some instability in the form of a whistle.

In practice, it is normal for diode detectors to generate harmonics of the fundamental frequency (in this case, 455kHz). However, there is a design deficiency in this set in that the detector output goes to the volume control, which is located right alongside the broadcast-band RF amplifier. As a result, the harmonics from the detector are induced into the broadcast band coils.

To prevent this, I tried inserting a miniature 1.5mH RF choke between C37 and C49 and this noticeably reduced the problem. In fact, with a strong signal, the instability was no longer evident. By contrast, in the B32 broadcast-band only version, only C37 is needed. The front-end layout is somewhat different in that model and the IF harmonic problem is not evident.

Summary

Like the B32 broadcast-band set, the B33 was an expensive receiver. As such, these sets would not have been produced in large numbers.

VALVES

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All receivers that tune from 10-30MHz in one sweep, such as this set, are quite critical to tune. AWA overcame this problem by fitting a small bandspread control, concentric with the main tuning control, and this does make tuning much easier.

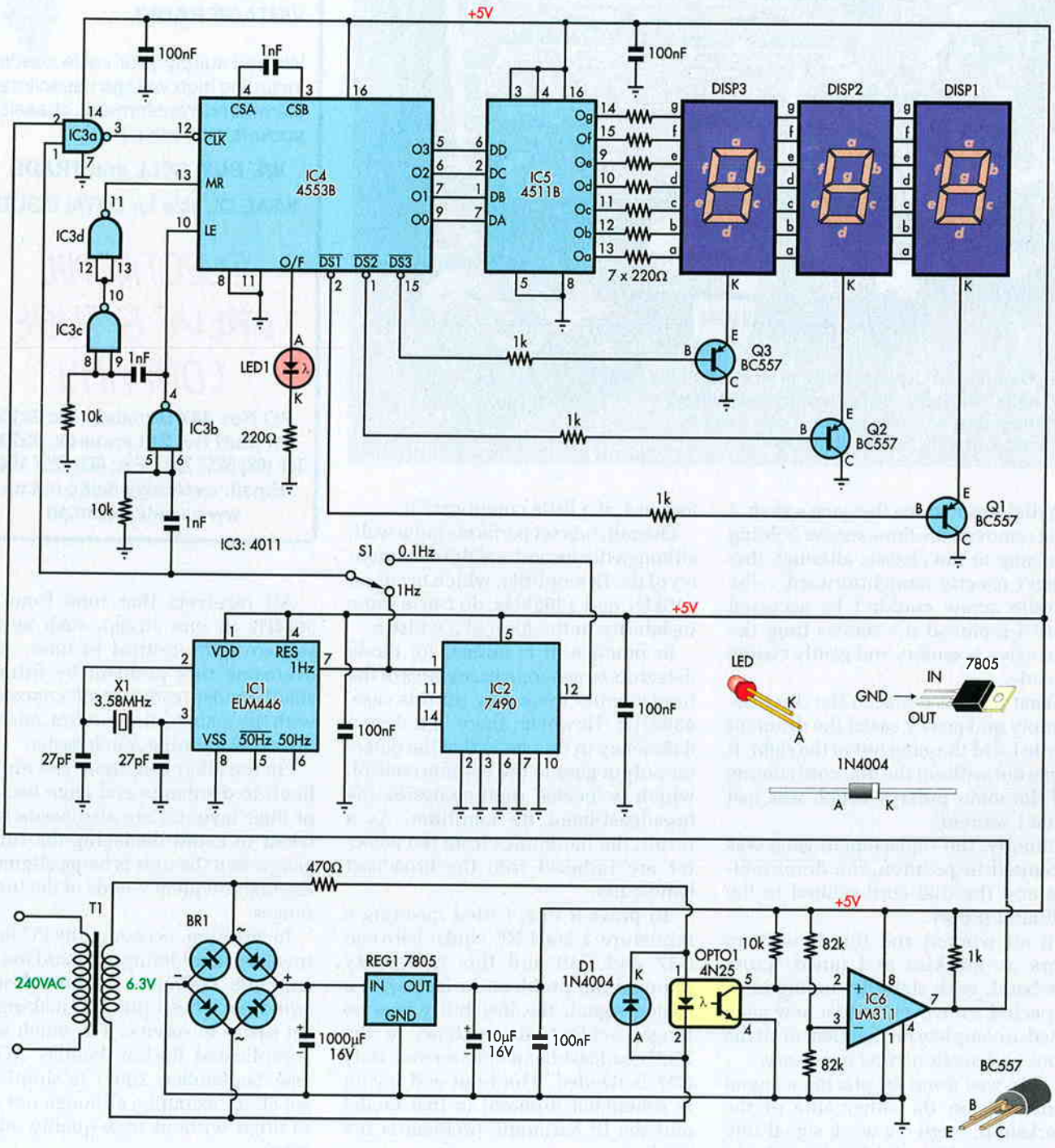
On the other had, these sets are difficult to dismantle and align because of their layout. Care also needs to be taken to avoid damaging the tuning gang when the unit is being aligned at the high frequency-ends of the tuning ranges.

In addition, access to the PC board involves desoldering the board from its supports. Perhaps a bit more thought could have been put into making the set easier to service. The much more complicated Barlow Wadley XCR30 (see September, 2002) is simpler to get at, for example, although not easy to align without high-quality equipment.

In summary, this is a set that's well-worth having – especially as it is complete with its instruction manual and a DC power supply (PS9). It now sits alongside its single-band brother in my collection. **SC**

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Mains frequency monitor

Here is a simple frequency counter designed to monitor the 240VAC mains supply. It has a frequency range of 0-999Hz, so it could also be used with 400Hz equipment.

Standard TTL/CMOS logic is employed for the counters and display drivers, while an ELM446 (IC1) generates accurate 1Hz pulses for gating. This device utilizes a 3.579545MHz crystal for its time-base, as commonly found in TV and

video circuits and even on old PC motherboards.

The mains frequency is sensed on the low-voltage side of the power supply transformer. Each positive going half-cycle illuminates the LED in an optocoupler (OPTO1). A diode (D1) across the input protects the optocoupler from excessive reverse bias voltage during negative half-cycles.

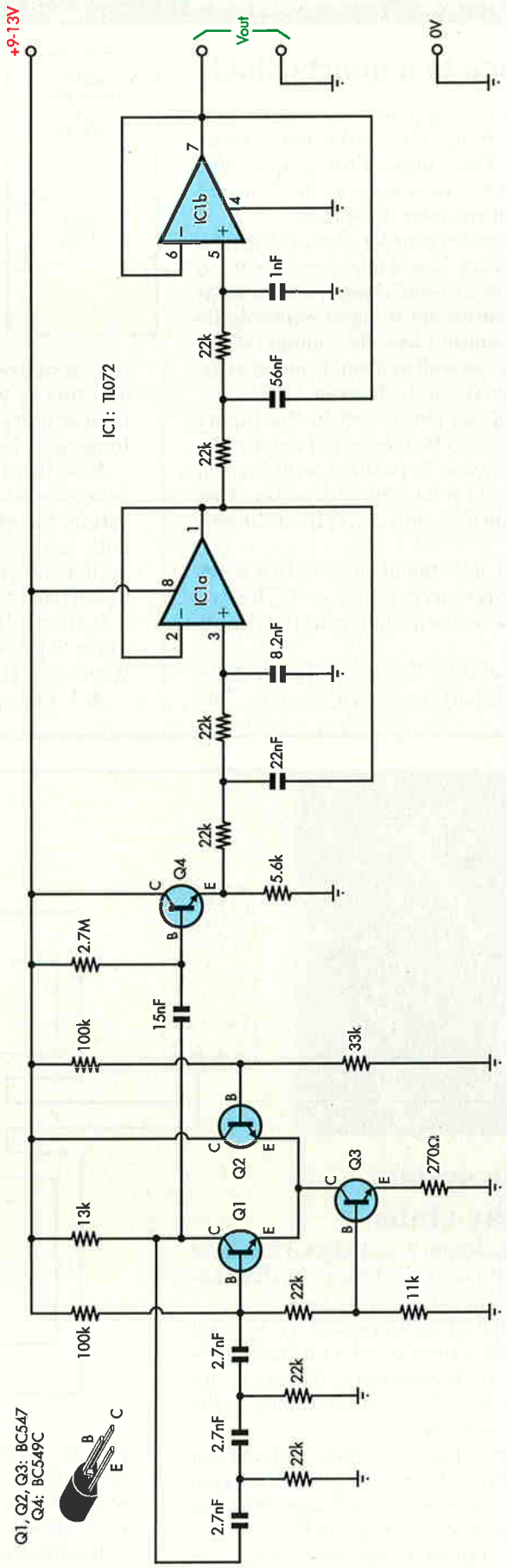
In turn, the optocoupler's phototransistor drives the non-inverting input (pin 2) of a voltage comparator (IC6). The comparator's job is to convert the slowly changing voltage into a square wave suitable for clocking the counter logic. This is achieved by biased the inverting input (pin 3) at the mid-point of the supply rail. Each pulse from the comparator's output advances IC4's count, which occurs about 50 times a second.

IC4 is a 3-digit BCD counter, with each of the counter outputs latched on O0-O3 in a time-multiplexed fashion. Further, outputs DS1-DS3 indicate which digit is latched, hence their use to enable the individual LED displays (DISP1-DISP3) via transistors Q1-Q3. A BCD to 7-segment decoder/driver (IC5) powers the selected display segments.

Referring back to the timebase generator (IC1), you can see that its 1Hz output is gated with the clock signal applied to IC3a. This means that the counter is enabled for exactly one second at a time. At the end of each 1-second period, the accumulated count is latched by a rising edge on pin 10 of IC4, after which the master reset signal on pin 13 clears the count for the next cycle. This timing sequence is generated with the aid of three NAND gates (IC3b-IC3d), together with two simple RC networks.

As mentioned, the crystal can be scrounged from any number of sources. The ELM446 50Hz timebase generator is available from **www.elmelectronics.com**. Readers in areas with 60Hz mains frequencies should order the ELM440, which can be substituted with only minor circuit modifications.

Craig Kendrick Sellen,
Carbondale, PA, USA. ($40)



RC phase-shift oscillator

This circuit provides a sinewave output with a frequency of approximately 1kHz and an amplitude of around 3Vpeak-peak. It uses four transistors and two op amps and is powered from a 9-13V DC source.

The circuit can be broken into three sections, being an RC phase-shift oscillator, a buffer and a low-pass filter. Three transistors and their associated components make up the oscillator. Transistor Q3 acts as a constant current generator for differential pair Q1 and Q2. The 13kΩ collector load for Q1 together with the constant current through it establish initial conditions for oscillation.

Three 2.7nF capacitors and three 22kΩ resistors act as the phase shift network, shifting the collector signal by 180° before feeding it back into the base circuit. The resultant oscillations are buffered by Q4, which is wired as a simple emitter-follower.

Two op amps and their associated components make up a 4th order 1dB dip Chebychev low-pass filter. The filter is tuned to a frequency slightly less than the oscillator frequency, giving a low distortion sinewave output with a 10V supply rail.

Malcolm Sharp,
Berala, NSW. ($45)

Add tick 'n' tock to a quartz clock

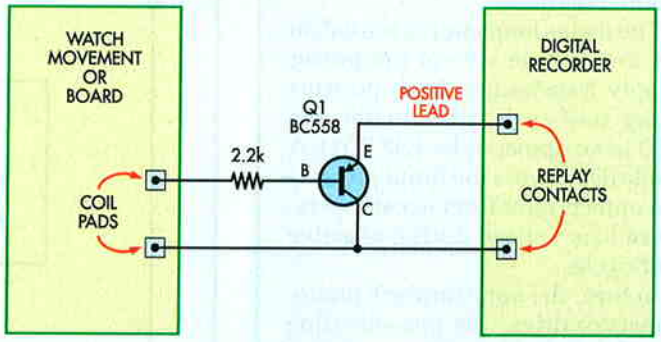
Classical clocks built using quartz movements miss out on one important thing – the comforting tick and tock of passing time. This simple little project idea corrects this deficiency, showing you how to add authentic sound to your master timepiece!

You'll need a small voice recorder, such as the type that attaches to a key ring. You'll also need access to a real clock – perhaps at a friend's home, clock dealer or museum. The recorder must have non-volatile memory, such that it doesn't lose its contents if the battery is disconnected, as well as a replay feature that requires only a brief push on the button.

First up, two wires are connected to the replay contacts so that replay can be controlled externally. Check which of these wires is positive with respect to the other, and mark it for later identification. Now record one tick and one tock (not more) from the real clock.

Next, open the clock movement and run two wires from the pads that connect to the drive coil. The two pairs of wires may now be connected using the simple circuit shown here.

In operation, the lead from the coil pad to the base of Q1 goes to 0V very briefly every two seconds. This brief negative-going pulse turns on the PNP transistor and this in turn activates the recorder long enough to hear a tick and a tock, marking two seconds on a long-case clock.



Note that the tick and tock of a clock are different from one another. One sound is due to an impulse action, the other a release, hence the need to record both sounds for an authentic effect. The sound recorder runs non-stop, so it should be powered from a plugpack to save on batteries.

Incidentally, a similar idea that uses a piezo transducer to produce a 1-second tick was presented in the November 2004 edition of SILICON CHIP.

A. J. Lowe, Bardon, Qld. ($30)

Joe Brandwyk is this month's winner of a Peak Atlas Test Instrument

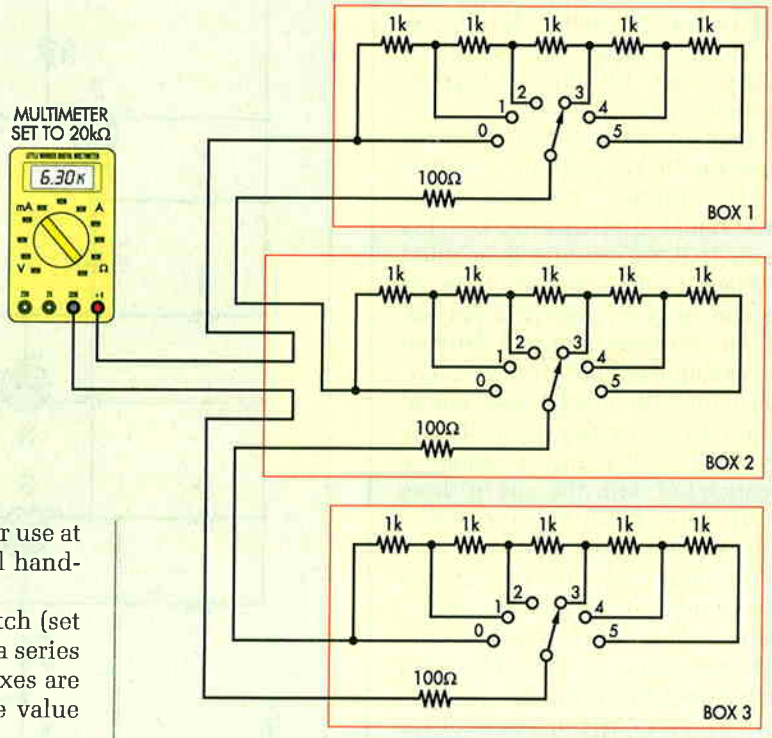
Simple judging system for photography clubs

This simple judging system was designed for use at a photographic club. It consists of three small hand-held boxes and an inexpensive multimeter.

Each box contains a 12-position rotary switch (set to six positions), which is used to select from a series of taps along a string of 1kΩ resistors. The boxes are wired in series, such that the total resistance value can vary between 0Ω and 15kΩ.

The multimeter is set to measure 20kΩ, with the last two digits blanked off with tape. This gives a convenient display of 0-15. A 100Ω resistor in series with each box prevents the meter from reading too low.

Since installation some years ago, the system has proven reliable and easy to use. If a multimeter with backlighting was used, the display would be readable in total darkness. However, light spill from the projector makes the display quite readable.



Joe Brandwyk, Happy Valley, SA.

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Interfacing a Picaxe to the 45s voice recorder

I've built the 45-Second Voice Recorder featured in the May 2005 issue and it works fine. However, I'm trying to interface it with a PICAXE 08M and have encountered some difficulty. Should the output of a PICAXE be enough, when toggled from low to high then back to low, to activate the rewind/playback of the chip when directly connected to pin 23 (/M7_End) of the HK828 via the 10-pin IDC header? Or do I require extra components?

My original plan had been to replace the Rew/Play switch with a small relay, although I would prefer to interface more directly. (B. B., via email).

● It should be possible to control the HK828 voice recorder IC with a PICAXE micro. A falling edge on M1-bar (pin 1) initiates playback, so you'd set the chosen PICAXE port bit as an output, idle high. You'd then pulse it low and back high again. Experiment to find the minimum pulse width – 100ms would be a good starting point.

Refer to the HK828 datasheet for more information. It's available from **http://www.honsitak-taiwan.com/list.files/list_pdf/hk828-2.pdf**

High power 13.5V DC supply

I'm looking for a project published years ago in SILICON CHIP or "Electronics Australia" magazine. It was a high current 12V supply using phase-controlled SCRs in the primary side of the transformer. Any ideas as to when it might have been? (R. C., via email).

● The project you refer to was a 13.5V 25A power supply for amateur transceivers, published in the May & June 1991 issues of SILICON CHIP. It used a Triac in the primary of the transformer. We can supply the back issues for $8.80 each, including postage.

Garage door remote controller

I am building the Garage Door Remote Controller featured in the October 2004 issue. On testing using the manual button on the PC board, the correct response is obtained; ie, Stop, Up, Stop, Down, Stop, Up, etc. However, when using the remote, I usually achieve Up, Down, Stop. It hardly ever stops until it has done a reverse. Why is this so? The above tests have been done on a small 12V motor not connected to anything.

Then, when I connect it to the motor coupled to my garage door, it failed to lift the door up (it got up about 30cm) and simply stopped. I have adjusted VR1 and VR2 in various ways to no avail. On a closer inspection, I realise that the output current draw for the kit is not enough to power my motor and lift the door up. Is there a way to increase the current output on the receiver unit or do you have a better suggestion? (R. E., via email).

● It's possible that you have a fault in the RF module. Check that it is properly soldered to the PC board and that the supply is 5V. If these checks are OK, you may need a new module.

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Enhancing The Video Enhancer

'I refer to the Video Enhancer & Y/C separator described in the August 2004 issue of SILICON CHIP. I have constructed this unit and found that although the adaptive digital comb filtering works well, the edge enhancement does not.

Because of the low bandwidth (3MHz) of VHS recordings, the rise time of the highest frequency luminance edges exceeds 100ns. The circuit explanation for the video enhancement states "all signal changes which last longer than selected delay lines will be cancelled out".

I have found that the output of the enhancer with VHS video is essentially zero. The enhancer is bypassed during sync because, as per the article, spikes would be added to the sync. The sync rise time from a VHS recording is about 300ns which exceeds the length of the delay lines by a large amount and would therefore not suffer distortion with spikes on edges.

I have checked the circuitry very carefully and all appears to be as it should be. I would appreciate your comments. (D. M., via email).

● The length of the longer delay line in the Y/C Separator/Enhancer was indeed something of a compromise, because the full cable length necessary to give a good measure of enhancement to low-bandwidth VHS signals was around six metres. This length was almost impossible to fit inside the box, so we reduced it empirically to a length which still seemed to give useful enhancement using the prototype.

If you want to achieve better enhancement of VHS signals, you might care to run a short length of cable from the "DL2" terminal pins on the PC board out to a BNC socket added to the rear panel of the box and then use this socket to connect a suitable long length of cable coiled up neatly outside the box.

The external cable would have a BNC plug at one end and a short circuit at the other, of course. This external cable arrangement would let you experiment with round-trip delay times and let you achieve the optimum edge enhancement for your system.

cerned, you can increase this by reducing the sense resistors to 0.1Ω or by increasing the 220kΩ resistors associated with IC3a & IC3b.

UHF/VHF tuner project for older TV sets

I have an old B&W VHF-only TV set sitting in my spare room which I would like to be able to use if I could "upgrade" it to also handle UHF and perhaps also digital as well as analog. My suggestion would therefore allow for any old B&W or older colour TV set to be brought back into service.

My idea is that the project might include either a separate VHF & UHF selector knob or an "up" and "down" button with an optional remote control available for both versions. Also, if suitable "black box" tuner units were available that would simplify the design, then so much the better.

Among the features of the "adapter" during the construction process would be the ability to either preselect a VHF output channel or allow the user to select the VHF output channel to be fed into the TV when installing the unit. The unit would be powered via a low voltage plugpack and would be located external to the TV as per the attached diagram. Since drawing the diagram I have just noticed that the addition of a 2-digit channel display would be required in the "up and down button" model. (P. M., via email).

● The solution to your quest is quite simple: use any old VCR, preferably one with a working remote control. It will tune over the entire UHF and VHF band. Just plug its modulated output into your old TV's aerial socket.

Deep Cycle Battery Charger Has Low Output

I have finished building the Deep Cycle Battery Charger (November & December 2004). It all seems to be functioning but I have a question.

The battery voltage reported by the unit seems to be lower than what I measure at the battery with a multimeter. For example, the charger shows 14.2V but a measurement across the battery terminals reads 14.5V on a digital multimeter.

As you can imagine, I am a bit worried about cooking some expensive batteries. Is this normal or is there some further testing I can do to find out if there is a problem? I did all the testing and test-point measurement and setup as per the article and it all looks good. (B. D.,via email).

● The circuit was designed to compensate for voltage drops across the leads. Make sure you used the specified length and gauge of wire. Alternatively, you can slightly recalibrate the battery reading so it is correct. So adjust VR4 a little for the display reading.

Reverse display for Speedo Alert

In your Speed Alarm kit (November & December 1999 issues), can you tell me how I can get the display to show in reverse? (R. W., Wellington, NZ.)

● The display cannot be shown in reverse without changing the lookup table that determines which segments are driven for a particular number to be displayed. This table is located within the software. We have not published or written any revised code for this although it is a very simple change in the lookup table to rearrange the segments that are driven.

Motorcycle power for GPS unit

I use a GPS on a motorcycle quite often. My son and I go riding in the bush and the GPS stops me from getting lost. I have a problem with the GPS switching off due to battery bounce from the bike vibration.

I want to run the GPS from the power

Notes & Errata

PICAXE-Powered Thermostat, February 2006: the reset signal from the output of the PICAXE is coupled to the rest of the circuit via a 100nF capacitor, whose output is connected to ground via a resistor. On the circuit (Fig.1), this resistor is shown as 22kΩ in value, whereas on the overlay diagram (Fig.2), it's shown as 20kΩ and in the parts list as 100kΩ. Although all of these values will work, the correct value is 22kΩ.

IO Controller, November 2005: the Windows-based software program can crash after running for an extended period – ie, when the logger reaches its maximum 2048 number. This bug has been fixed and the revised software posted on the SILICON CHIP website.

lead but my bike is a 1984 model with AC electrics (6V). I was looking for a voltage converter that will step up the 6V AC to somewhere around 10-12V DC as my GPS will run from 8-30V (Garmin GPS12cx). Would the 3V-9V DC-DC converter from March 2004 issue be suitable for this application with some mods or have you produced any other kits that would be suitable? (C. L., Ingham, Qld.)

● The 9V DC-DC Converter has a maximum output current of 100mA (ideally), which is probably too low for your GPS. One possible solution would be to modify the "Adjustable DC-DC Converter for Cars" (June 2003). Assuming a 6V AC input and 13.8V DC output with about 500mA maximum load, the following changes to the converter will be required:

(1). Replace the two 1000µF input capacitors with 2200µF 25V low-ESR units (Jaycar RE-6330).

(2). Replace the 1nF capacitor connected to pin 3 of IC1 with a 680pF ceramic disc type.

(3). Replace the 0.1Ω 5W resistor with 2 x 0.33Ω resistors (1W or higher) connected in parallel.

(4). Replace MOSFET Q1 with a "logic-level" type; eg MTP3055EL or Jaycar ZT-2271.

(5). Replace D3 with a wire link.

(6). Using the specified wire diameter (1.0mm), increase the number of turns on L1 so as to make one complete layer without gaps. We expect that the toroid will accommodate at least five turns more than specified in the construction details.

(7). Wire up a 2A (or higher) bridge rectifier (eg, Jaycar ZR-1314 or ZR-1360) between the AC input leads and the converter's 12V DC input terminals.

After construction, be sure to adjust and test the unit on the bench using a transformer and a dummy load. You can use the 6.3V tap of a type 2155 transformer (eg, Jaycar MM-2002) and a 68Ω 5W resistor would make a suitable load (it will get very hot!). Adjust VR1 to get 13.8V at the output.

Once the unit has been tested, the entire assembly should be thoroughly cleaned and all components (apart from the 0.25W resistors) securely glued to the PC board to prevent vibration related problems later. Depending on your installation, you will probably also need to seal the case to prevent moisture ingress. Spraying the assembly with circuit board lacquer may also help.

You might also consider an off-the-shelf solution such as Jaycar's DC-DC Step-Up Converter (Cat. AA-0264) coupled with a rectifier and filter. SC

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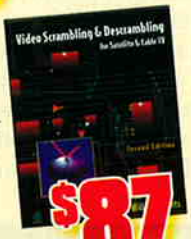

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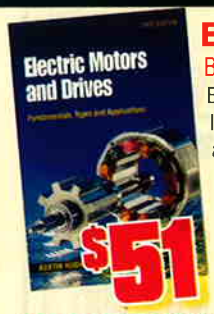

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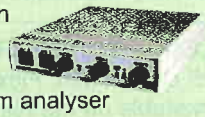
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